POWER

Volume 57 New York, January 30, 1923 *Number* 5

The Federated American Engineering Societies

WHAT is the Federated American Engineering Societies? Over 50,000 American engineers belong to it and do not know.

When they realize that as members of its constituent societies they are each paying dues to the "Federated," the first question that they ask is, "What are we getting out of it?"

When they get the Vision — when they appreciate the ideals upon which it is founded and sense the opportunity and need for its services — they ask, "What can ve do for it?"

Our national housekeeping is badly disordered. In less than a century we have passed out of the provincial stage of industry. The individualistic Old Oaken Bucket has been replaced by the communistic reservoir or standpipe. The village butcher has succumbed to Armour and Swift and the neighborhood cobbler to the genial gentleman whose portrait adorns the advertising pages of the popular magazines.

And we are beginning to realize the possibilities of organization, of co-ordination, of a systematic, scientific study of our resources and environment; the application to the problem of civilization of the new methods and discoveries that research is revealing; the development of the art of living together.

The best use of exhaustible natural resources, the avoidance of waste of time, material or labor, the procurement of the greatest possible degree of human happiness and universal well being, should come of the intelligent, collective employment of accumulated knowledge, industrial training and scientific research.

The orderly reorganization of a system of diversified and often conflicting self-centered interests into an interlocking system of production, transportation and distribution devoid of wasted effort and lost motion; the impressment of the necessary regulative and directional forces without cramping initiative and motivating purpose; must be done against the inertia and resistance of established privilege and with the repression of unreasoning radicalism.

The belief is growing that the unemotional, analytical, practical engineering type of mind and of man must be looked to to bring this about.

When the Federated American Engineering Societies have focused the thought of the engineering profession upon one or two of these problems and impersonally and untemperamentally have marshalled the facts and presented their conclusions with such force and obvious fairness as to make it manifest that they hold a brief for the American People they will have the spontaneous, enthusiastic support, not only of the profession but of the public.

F. R. Low

Remote Control Made Possible Economical Development of a Small Water Power

By R. PHILIP HART
Manager, Cazenovia Electric Company

WATER-POWER site used by an old mill and abandoned was redeveloped with a remotely controlled station and operated in parallel with another plant three thousand feet away,

THERE are many small water powers that have not been developed because of the high cost of development or of operation. As the cost of fuel increases, these small water powers are attracting more and more attention. Since the automatically or semi-automatically controlled plant saves the cost of an operator, it becomes economically possible to develop small water powers that could not be done with the attendant type of plant. How one power company handled this problem will be of interest to many who are operating small water-power plants or are contemplating their construction.

In 1903 T. W. Thayer & Co. installed a waterwheel at their Ferndell Mill on the Chittenango Creek, near Cazenovia, N. Y. The wheel was rated at 200 hp. and belted directly to the lineshaft of the mill. The shaft was also driven by a 200-hp. steam engine, which did the governing and supplied the necessary power in excess of that developed by the waterwheel. The original wheel operated under a 35-ft. head and received its water from a dam 1,500 ft. distant, through a 60-in. white-pine wood-stave pipe banded by ½-in. round iron hoops every 18 in. This pipe was for the most part laid along the surface of the ground in a swamp. It crossed the creek bed by going underneath and was for a part of its length completely buried underground. This plant was operated until 1916, when the firm discontinued the use of the mill. During these thirteen years of operation considerable trouble was experienced with the wood-stave pipe, due to leaks, which were largely caused by the earth's settling and the rotting of the wood staves.

The plant lay idle until 1920, when it was proposed to redevelop the water power to help out the main plant, Fig. 1, of the Cazenovia Electric Co., which is situated on the same creek 1,500 ft. above the site of the Ferndell dam, and is a combination steam and water-power plant. Work was begun in 1921, but was not finally completed until the latter part of July, 1922. Fig. 4 shows the relative locations of the two plants. The head at the main plant is 14 ft. and that at Ferndell 35 feet.

In considering a development of the old site, a manually controlled station was found to be entirely too expensive to operate, as it would require three shifts of attendants. This led to the choosing of a remote control or semi-automatic equipment for which no attendant would be required. The equipment finally adopted was an S. Morgan Smith wheel with a Woodward governor and General Electric generating and control equipment. The wood-stave pipe was manufactured and erected by the Continental Pipe Company.

The wood-stave pipe, which was rebuilt to the same dimensions as the old one, is 60 in. inside diameter,

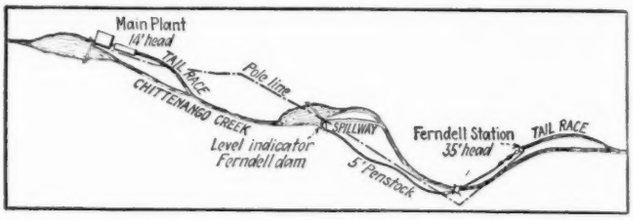


FIG. 4—SHOWS LOCATION OF MAIN AND REMOTELY CONTROLLED PLANTS

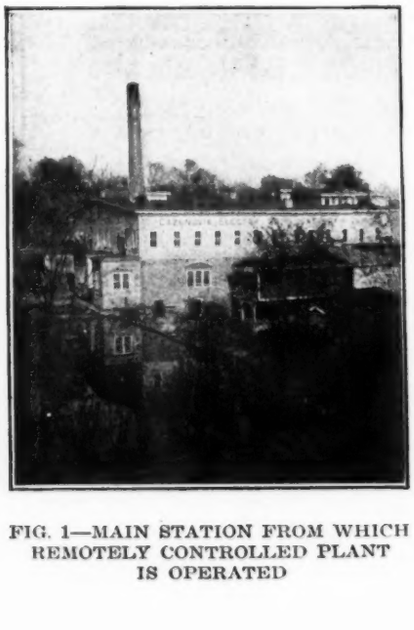


FIG. 1—MAIN STATION FROM WHICH REMOTELY CONTROLLED PLANT IS OPERATED

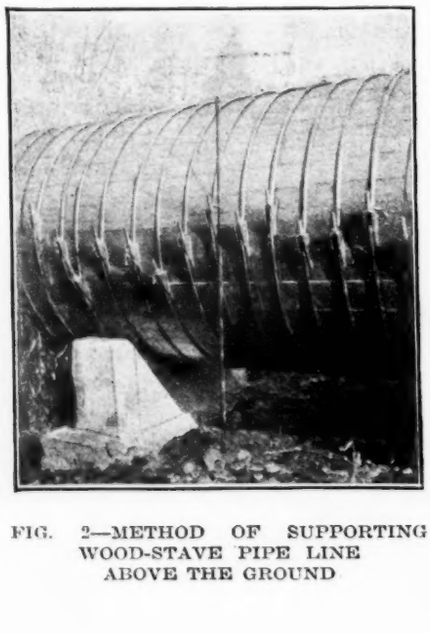


FIG. 2—METHOD OF SUPPORTING WOOD-STAVE PIPE LINE ABOVE THE GROUND

FIG. 3—WATER LEVEL INDICATOR AT INTAKE OF REMOTELY CONTROLLED PLANT

of creosoted Washington fir, supported every ten feet on concrete saddles, one of which is shown in Fig. 2. Owing to water conditions it was found impossible to remove and rebuild the old piece under the creek, so the new was joined to it at the upstream end by a concrete pier and connector. At the downstream end the connection was made by tapering the new pipe and calking it into the old one. For a considerable distance on either side of the creek the old pipe had

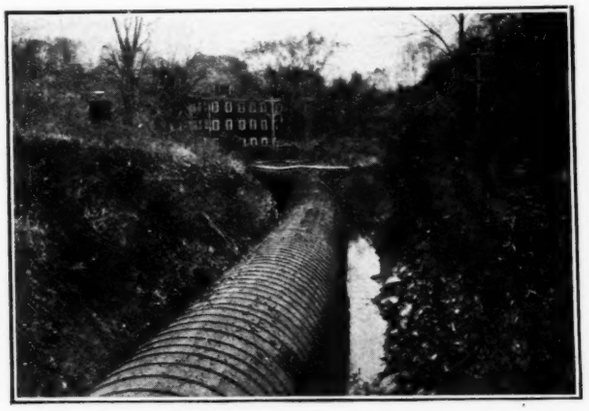


FIG. 5—PIPE LINE ENTIRELY EXPOSED TO ALLOW FREE CIRCULATION OF AIR

been buried underground, but it was considered best to have the new one entirely exposed, with a free circulation of air on all sides to prevent decay, as in Fig. 5.

The forebay, Fig. 3, was largely rebuilt, as the old one was not in usable condition. The racks are 14 ft. wide by 11 ft. long, made of $\frac{5}{16}$x2$\frac{1}{4}$-in. iron set edgeways to the direction of flow and are constructed in sections one foot wide. A spacing of one inch is used between adjacent bars. Located at the intake is the headwater-level indicator, which was constructed locally, and is to show the operator in the main plant how to load the turbines in this plant to supply the necessary amount of water to the Ferndell plant. This water-level device has given excellent service, and its construction and operation will be described in a future article. It was found necessary to make this device, since the ones on the market were too elaborate and high-priced for the service desired.

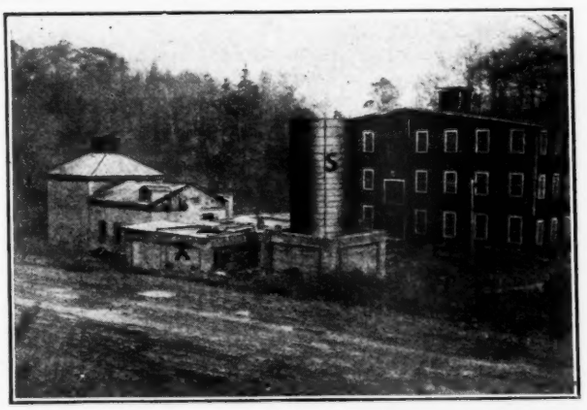


FIG. 6—POWER PLANT AT *X* AND SURGE TANK AT *S*

The building for the station is shown at *X* in Fig. 6, and the surge tank at *S*. The building is 48x24 ft., with the roof left flat for the addition of a second story for other purposes. Fig. 7 shows the position of the machinery in the plant and also gives an idea of the construction. Reinforced-concrete girders and beams were used throughout. At the left is the one-panel switchboard and back of it the rack for the outgoing power wires. The rack supports also the lightning arresters, choke coils, disconnectors and instrument transformers. Station lighting is provided from a one-half kilowatt transformer, connected on the line side of the disconnectors. This is done so that in case of repairs at night when the plant is shut down, lighting and power for drills, grinders, etc., can be taken from the main station. Lighting units are three in number, each consisting of an RLM dome fitted with a 200-watt type "C" lamp. These furnish an illumination of about 3$\frac{1}{2}$ foot-candles, which is sufficient for all the necessary adjustments and inspections. In fact, this illumination is much above that usually provided in plants of this size and type.

The plant equipment consists of a double-flow horizontal wheel with 20-in. runners, directly connected to a 225-kva. 2,300-volt 600-r.p.m. 60-cycle three-phase alternator to which a 125-volt exciter is directly connected. Governing is taken care of by a 3,000-ft.-lb. oil-pressure governor fitted with an electric motor to control the tension on the flyball spring, and thus control the speed of the outfit. A solenoid-operated pilot valve is also used, one of whose coils must be energized for the governor to operate. The control panel at the main station is shown in Fig. 8. Before proceeding with the explanation of the features of the electrical operation, it should be noted that the two plants are connected by a pole line which has two crossarms; the top one carries the three line wires of No. 2 copper, and the control cable which contains three No. 10 copper wires. On the lower crossarm are two telephone wires and three wires for the water-level indicator; all these latter are of galvanized steel.

Referring to Fig. 9, which shows the wiring of the installation, the operation in starting is as follows: The operator at the main plant moves button *A* to start position; this energizes the lower governor solenoid *P* and runs the governor-control motor

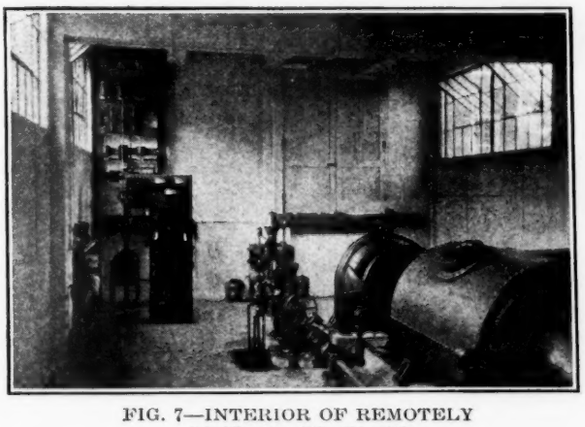


FIG. 7—INTERIOR OF REMOTELY CONTROLLED PLANT

toward the fast position. The solenoid raises a valve which allows the governor to open the gates and start the wheel and generator; as they do so, the exciter builds up its voltage and that of the alternators, which latter the regulator holds at 2,100. As soon as about 80 volts is obtained on the secondary of the potential transformers, the upper governor solenoid *P* is energized and holds open the governor valve, making it no longer necessary to hold button *A* in the starting

position. When the operator at the main plant sees the voltage at 2,100, he plugs in the synchronism indicator and synchronizes by controlling the speed of the incoming machine from button *A*, and closes the oil switch, which is located at the main station. Once phased in, the load can be increased or decreased by operating button *A*. To take the machine off the line, the load is reduced to zero by operating the governor control motor from button *A* and the oil switch is opened, then the button is held in the slow position until the machine slows down sufficiently to reduce the voltage on the governor-solenoid coil to less than 80 volts, when it drops its core, closing the governor valve and completely closes the gates.

The mechanism is protected against several possible troubles in an unattended station. Each bearing is provided with a temperature relay *T* of the circuit-closing type. These, when high temperature causes also energizes contactor *F* and reduces the exciter voltage, etc.

The plant was started July 29, 1922, and has run almost continuously ever since. The troubles which it has developed and which have all been easily overcome, are:

A. Bad heating of governor control motor, found to be due to grounded armature, which was replaced. It should be noted that the common leg on the control cable should be from the grounded side of the supply, as in Fig. 9. In case of grounds in the control motor it will then be unable to run unless button *A* is actuated.

B. Plant tripped out from main station on light loads. This was found to be due to improper adjustment of plant governor compared to engine governors at main station and was easily cared for when this adjustment had been properly made by button *A*.

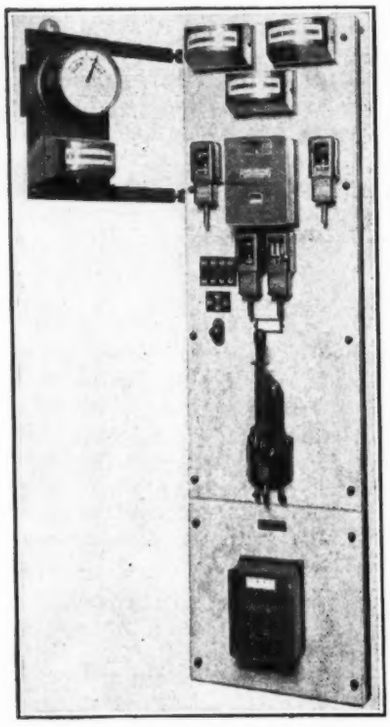


FIG. 8—CONTROL PANEL IN MAIN STATION

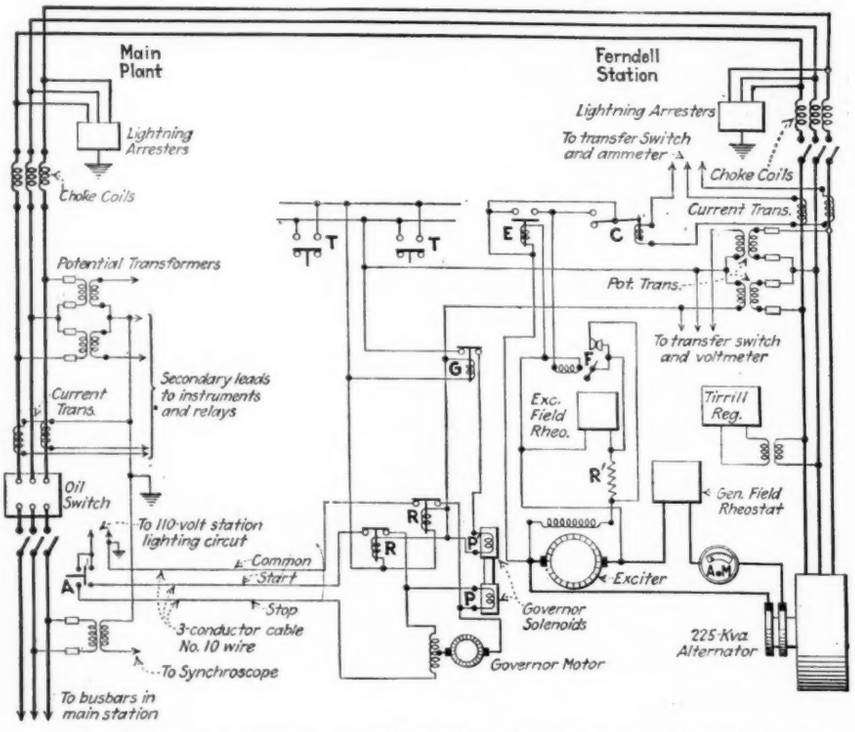


FIG. 9—WIRING DIAGRAM OF CONTROL PANEL IN MAIN STATION AND CONTROL EQUIPMENT IN SEMI-AUTOMATIC PLANT

them to close, open governor relay *G* and the two relays *R*, which are hand reset and prevent the operator from restarting the station after shutdown due to a hot bearing. In this case the plant must be visited, inspected and relays *R* reset by hand, before it can again be started. High exciter voltage causes relay *E* to close, which energizes contactor *F* and puts a high resistance *R'* in the exciter field circuit, lowers the machine voltage to about 800 and causes power to flow from the main station into the generator at the automatic station, which in turn trips a reverse-power relay at the latter. In this case the plant will generally continue to run after the oil switch is tripped, unless, as occasionally happens, the voltage on the governor solenoid stays down long enough to drop its core and shut down the governor. Excess current causes the same series of operations as for high exciter voltage, but acts through the contact-making ammeter *C*, which

C. Total stoppage of plant. Investigation showed that one of the collector ring's brushes had roughed it up and started to arc, which burned the ring so as to necessitate grinding. When grinding of the ring had been done, the plant was started and in as good shape as new. The bad condition of the collector ring in the first place was probably due to some insignificant original defect in the surface of the ring.

The plant is inspected twice daily. Each inspection takes about one hour's time, on the average, including the inspection of forebay and indicator, and raking racks, if necessary. The telephone system is tested at each inspection. Once each week the inspector walks the line and flume to note anything wrong. About two hours daily is required for attendance instead of twenty-four as would be necessary for manual operation. This saving of twenty-two hours daily made the plant investment possible.

The operation of the two plants in parallel upon the same stream has some interesting features. The main station is of old-fashioned design and consists of two steam engines and one waterwheel, all driving one lineshaft which is belted to two single-phase alternators. It should be stated that the reason for installing a three-phase machine at Ferndell is because it is intended to rebuild the main plant for three-phase during this winter. Generally, the main plant is operated with

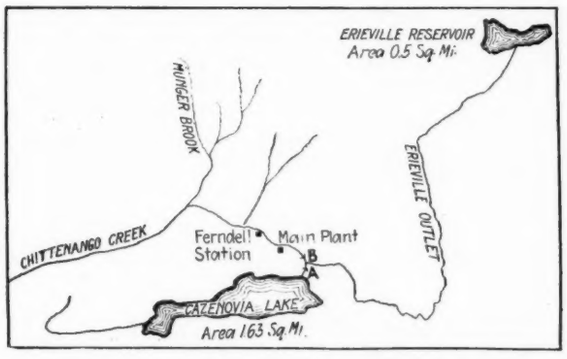


FIG. 10—RELATION OF STORAGE RESERVOIRS TO POWER STATIONS

its waterwheel on a fixed gate and allowing whichever engine is running to do the governing. Ferndell frequently runs in parallel with this combination. When running both water powers and no steam, it is necessary to run the wheel at the main plant open wide enough to give Ferndell sufficient water for its operation, as there is very little storage in either pond. There is a nice point of balance between the gate openings of the two plants. If the main-station gates are not open wide enough, the wheel develops a small amount of power and Ferndell, to carry the balance of the load, draws down its pond much faster than the tailrace from the main plant flows into it, with the result that in a short time the head on Ferndell is considerably reduced. The other extreme is when the main-station gates are too wide open; then the power demand on the new plant is less and the Ferndell pond becomes filled up and water is wasted over the crest of the dam. In assisting the operator to control the water level, the water-level indicator previously referred to has proved invaluable.

Another interesting feature of the whole problem is that both the ponds feeding Chittanango creek are reservoirs for the state barge canal system and that the outflow from both is under state supervision. The map in Fig. 10 shows Erieville reservoir and Cazenovia Lake, which combined have a drainage area of 54 square miles. The demand on these two ponds for canal purposes is more or less regular, but of course there is an excess of water in the months of heavy rainfall. For instance, during last summer the water was sufficient to carry all loads during the month of August. Even in months of low water the Ferndell plant is of great help in carrying a small load twenty-four hours daily, in some cases all except the evening peaks. There are two dams, *A* and *B*, Fig. 10, and by manipulating the gates of these dams, water can be drawn directly down the creek from Erieville or from Cazenovia Lake, or may be drawn from Erieville to fill Cazenovia Lake.

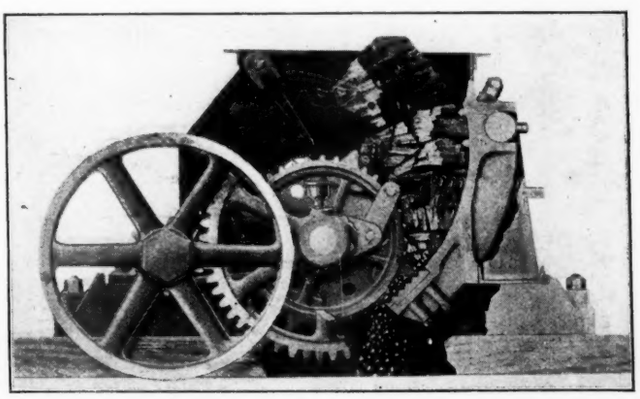
This company's experience with the remote-control station has been more than satisfactory. The troubles experienced have been much less than anticipated and insignificant. It is the writer's opinion that if the small companies throughout the country were thoroughly acquainted with the simplicity, economic soundness, easy installation and operation of remote-control water-power plants, they would not hesitate to use them in developing small streams on abandoned or on new sites.

New Single-Roll Crusher Is Not Injured by Foreign Matter

Of the S-A single-roll coal crusher, the predominant feature is the flexible attachment of the roll which permits it to rise automatically to pass tramp iron or other foreign material without undue injury to the machine. The roll floats radially about the countershaft on two arms. A spring and toggle device holds it in the normal crushing position and upon occasion permits the movement indicated by the dotted lines. The roll is made of cast iron in ring sections with cast teeth and, at intervals, manganese slugging teeth leaded and calked in place. Any one of the rings may be replaced.

Stationary back plates, made in sections with manganese wearing tips, withstand the crushing action. These plates are anchored to a short cross-shaft supported by two cast pedestals braced by forged steel rods and held in place by structural-steel stops. As indicated in the illustration, a swinging bypass gate is provided to permit sized material to pass through the crusher without going between the roll and the back plates.

The crusher is equipped with cast-iron side frames containing inspection doors. To balance the load on the main countershafts, there are two sets of cut cast-steel reduction gears. A feature safeguarding the



S-A SINGLE-ROLL COAL CRUSHER

crusher against damage is the provision of a breaking pin safety hub in the flywheel. In the event of accidentally clogging the machine with foreign material, the pin will shear and permit the flywheel to run free.

This single-roll crusher is made by the Stephens-Adamson Manufacturing Co., of Aurora, Ill.

A maximum voltage rating is usually given on the nameplate of current transformers, which merely indicates the strength of the insulation, and the transformer must not be used on voltages above that rating, but may be used on voltages below it. For instance, a transformer marked 6,900 volts maximum may be used on a 2300- or 100-volt circuit, but not on an 11,000-volt circuit.

Stratification of Gases Within a Boiler Furnace

By W. C. STRUNK*

METHOD of Taking Combustion Chamber Gas Samples—Four Sets of Analyses Show Air Distribution in Furnaces—Operating Relation of CO_2 and O_2 Shown—Method Suggested To Improve the Combustion Efficiency

SOME time ago it was thought advisable to make a study of the stratification of the gases, or in other words, the distribution of CO_2, within the furnace of a modern boiler setting. The boiler units selected, Fig. 1, were designed to operate normally at approximately 300 per cent rating, and the investigation was conducted while operating near this rating. A series of three furnace gas surveys, at 310 per cent rating, were made with the results shown in the tabulations. A further test at 360 per cent rating with a different design of side tuyere showed the same general stratification at higher percentages of CO_2.

Method of Taking Samples

An ideal method for making a study of this kind would be to obtain forty samples simultaneously. This could be done, but would require the use of elaborate and expensive apparatus. It was decided, however, that the information obtained by the methods following would be accurate enough for the purpose desired. A single sample of gas was taken and analyzed and then the next sample, etc. Whenever a sample of gas was obtained in the furnace, another sample of flue gas was also secured from the third pass. After some experimenting, a 15-ft. water-cooled gas sampling pipe was developed, which would withstand the furnace temperature. The sampler was not only subjected to a furnace-gas temperature of about 2,400 deg. F., but also to the radiant heat from the fire; it was imperative to maintain a constant flow of cooling water, for with a fluctuating water supply, a steam pressure developed which would prevent sufficient cooling water from circulating. A water pressure of 50 lb. per sq.in. was found necessary. Analyses of the gases in the furnace were obtained by means of an Orsat apparatus.

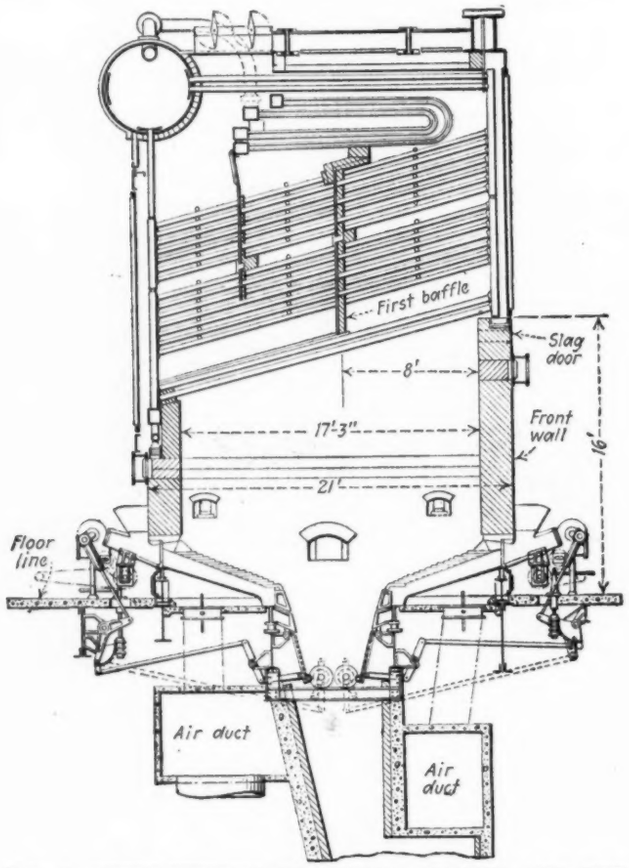


FIG. 1—CROSS-SECTION OF STOKER, BOILER AND FURNACE FROM WHICH GAS SAMPLES WERE TAKEN

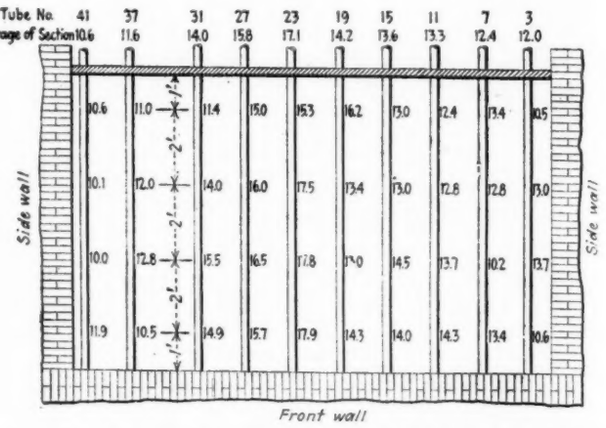


FIG. 2—PLAN VIEW OF POINTS IN FURNACE CHAMBER WHERE FLUE-GAS SAMPLES WERE TAKEN. PERCENTAGES OF CO_2 ARE INDICATED

Explanation of Sampling Points

Fig. 2 shows a plan view of points where flue-gas samples were taken. These were drawn under every fourth tube, until the thirty-fifth tube, close to the left-hand wall, was reached. The coal chute in front of the boiler made it impossible to insert the sampler in the slag cleaning door at this point, so it was passed and the sampler placed under the thirty-seventh tube in the usual manner.

Fortunately, doors were provided in the front wall directly below the front header for removing slag from tubes with a steam lance; these doors were well located for a survey of this nature. The water-cooled sampler was inserted under the various boiler tubes as indicated on Fig. 2, and samples were taken at distances of 1, 3, 5 and 7 ft. from the front wall. The space between the front wall and the first baffle was 8 ft. so that the end samples under each tube were taken 1 ft. from the front wall and the first baffle respectively. The

*Stoker Department, Westinghouse Electric & Manufacturing Co., Philadelphia, Pa.

samples were also taken about three feet below the first row of tubes.

During the surveys the stoker and boiler were operated by the regular boiler-room crew under the usual daily load conditions. No special interest was taken in watching the fires. However, care was exercised to maintain approximately 0.1 in. suction in the furnace at all times by adjusting the speed of the induced-draft fan.

Fuel Bed and Gas Temperatures

The temperature of the fuel bed varied from 2,600 to 3,000 deg. F.; gases under the first tube, 2,200 to

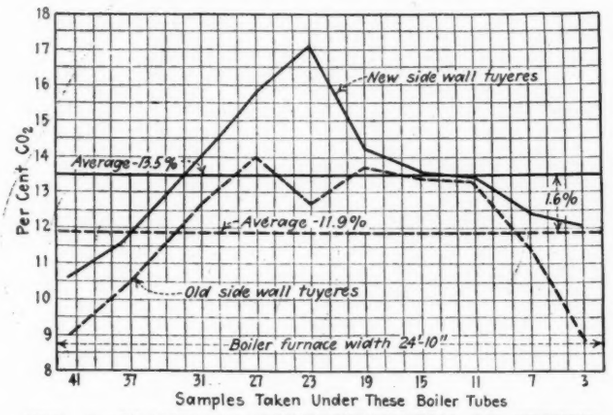


FIG. 3—GRAPHICAL REPRESENTATION OF STOKER OPERATION WITH OLD SIDE TUYERES AND NEW-TYPE EXTENSION SIDE WALL TUYERES

2,500, and the gases above the second tube 1,700 to 1,900 deg. F.

On the first, second and third gas surveys the old side tuyeres, Fig. 4, were used but the Westinghouse new type side wall extension tuyeres, Fig. 5, were used on the fourth survey. Considerable improvement in the CO_2 content near the side walls may be noticed on the fourth survey, Fig. 5, due principally to the installation

TABLE I—SURVEY WITH OLD-TYPE SIDE TUYERES

Average rating of boiler	311 per cent
Duration of survey	4 hours, 12 min
Average CO_2 in furnace	12.1 per cent
Average CO_2 at top third pass	11.8 per cent

Per Cent CO_2

Distance from Front Wall, Ft.	Sample Taken Under Boiler-Tube Number 3	7	11	15	19	23	27	31	37	41
1	8.4	11.1	10.3	15.0	16.5	13.0	14.7	12.5	11.0	9.0
3	10.3	11.0	9.7	12.5	14.5	14.8	17.2	14.0	12.7	7.6
5	9.8	8.8	11.8	13.0	14.0	14.6	16.0	16.2	11.8	8.6
7	8.8	10.7	11.3	11.8	13.4	14.0	14.3	11.5	11.0	8.2
Average.....	9.3	10.4	10.8	13.1	14.6	14.1	15.5	13.6	11.6	8.4

TABLE II—SURVEY WITH OLD-TYPE SIDE TUYERES

Average rating of boiler	309 per cent
Duration of survey	5 hours, 15 min.
Average CO_2 in furnace	11.3 per cent
Average CO_2 at top of third pass	12.2 per cent

Per Cent CO_2

Distance from Front Wall, Ft.	Sample Taken Under Boiler-Tube Number 3	7	11	15	19	23	27	31	37	41
1	5.6	11.1	14.3	13.8	11.7	13.3	11.4	13.0	6.0	7.0
3	7.8	13.0	15.3	13.3	12.3	10.2	12.4	9.2	11.6	8.4
5	7.7	10.9	16.4	16.3	12.8	11.6	11.0	11.3	8.9	8.0
7	7.1	12.0	17.0	14.2	12.5	....	13.6	10.8	8.2	8.0
Average.....	7.1	11.8	15.7	14.4	12.3	11.7	12.1	11.1	8.7	7.9

of these tuyeres. The CO_2 has been increased near side walls by 15 to 35 per cent, which means materially increased combustion efficiency.

Relation of Slag to Gases

It was interesting to note that the heaviest slag accumulation was on the tubes in the central portion of the furnace. This was of a hard and vitreous structure, having considerable iron in the "OUS" state, referring to ferrous iron oxide FeO. The tubes near the side walls were splattered here and there with masses of soft and friable slag, which had iron in the "IC" condition, such as ferric oxide, Fe_2O_3. This condition may be explained by studying the gas analyses. There was a lack of air at times in the central portion of the furnace, while near the side walls was an excess of it. A number of complete analyses were made of

TABLE III—SURVEY WITH OLD-TYPE SIDE TUYERES

Average rating of boiler	309 per cent
Duration of survey	3 hours, 35 min.
Average CO_2 in furnace	12.4 per cent
Average CO_2 at top third pass	11.9 per cent

Per Cent CO_2

Distance From Front Wall, Ft.	Sample Taken Under Boiler-Tube Number 3	7	11	15	19	23	27	31	37	41
1	10.3	11.9	14.4	12.2	14.3	13.0	16.7	14.1	10.9	10.7
3	9.8	13.4	14.2	13.0	13.6	13.5	14.4	12 0	11.0	13.8
5	8.9	10.8	11.4	14.1	15.6	10.8	13.1	13.5	8.5	7.8
7	10.6	12.8	14.0	12.3	13.3	....	13.3	13.4	11.5	11.0
Average....	9.9	12.2	13.5	12.9	14.2	12.4	14.4	13.3	10.5	10.8

TABLE IV—SURVEY WITH NEW-TYPE EXTENSION SIDE TUYERES

Average rating of boiler	364 per cent
Duration of survey	3 hours, 55 min.
Average CO_2 in furnace	13.5 per cent
Average CO_2 at top third pass	.....

Per Cent CO_2

Distance From Side Wall, Ft.	Sample Taken Under Tube Number 3	7	11	15	19	23	27	31	37	41
1	10.6	13.4	14.3	14.0	14.3	17.9	15.7	14.9	10.5	11.9
3	13.7	10.2	13.7	14.5	13.0	17.8	16.5	15.5	12.8	10.0
5	13.0	12.8	12.8	13.0	13.4	17.5	16.0	14.0	12.0	10.1
7	10.5	13.4	12.4	13.0	16.2	15.3	15.0	11.4	11.0	10.6
Average....	12.0	12.4	13.3	13.6	14.2	17.1	15.8	14.0	11.6	10.6

TABLE V—SUMMARY OF RESULTS. AVERAGE OF THREE SURVEYS WITH OLD-TYPE SIDE TUYERES

Per Cent CO_2

Average CO_2 Value	Sample Taken Under Boiler Tubes Number 3	7	11	15	19	23	27	31	37	41
No. 1.....	9.3	10.4	10.8	13.1	14.6	14.1	15.5	13.6	11.6	8.4
No. 2.....	7.1	11.8	15.7	14.4	12.3	11.7	12.1	11.1	8.7	7.9
No. 3.....	9.9	12.2	13.5	12.9	14.2	12.4	14.4	13.3	10.5	10.8
Average.....	8.8	11.5	13.3	13.4	13.7	12.7	14.0	12.7	10.3	9.0

gases in the central portion of the furnace, and CO was found in amounts as high as 0.7 per cent, but occasional

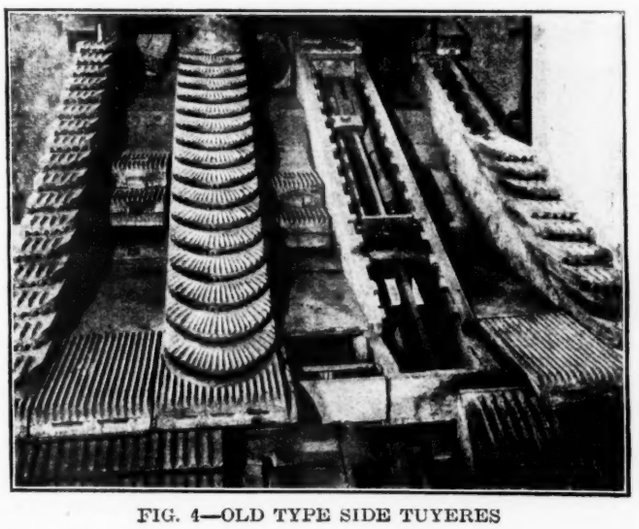


FIG. 4—OLD TYPE SIDE TUYERES

attempts to show CO in gases having a CO_2 content of over 16 per cent failed to indicate an amount measurable with an Orsat apparatus.

It may be noticed that the average CO_2 in the furnace on two surveys was higher than that obtained in the top of the third pass, while on one survey the reverse was found. This latter result may be due to the fact that slightly different conditions existed in the furnace and is difficult to explain.

There is no relation existing between the CO_2 samples

taken simultaneously in the furnace and top of the third pass. This was checked by noting the apparent diversity of the analyses of these samples.

Construction of Stoker and Boiler

Fig. 1 shows a cross-section of the stoker, furnace and boiler. The slag doors are directly below the front header, above the bulb beam for holding the bonding tile in position. The stoker is a Westinghouse underfeed, having 13 retorts each at the front and the rear ends of boiler, 16 tuyeres long with a double-roll clinker grinder operated from the stoker crankshaft. The boiler is of the water-tube type, heating surface, 15,290 sq.ft. 16 tubes high and 42 wide; the tubes are 20 ft. long.

Discussion of Operating Results

Fig. 3 is a graphical representation of the CO_2 results from operation. Solid curves show the stoker using the new extension side wall tuyeres, while the broken curves represent results obtained with the old standard tuyeres. It is interesting to note the improvement in CO_2 content at the sides of the boiler furnace by the use of the new extension side-wall tuyeres.

From the surveys it can readily be seen that the higher CO_2, with some samples showing CO, are found

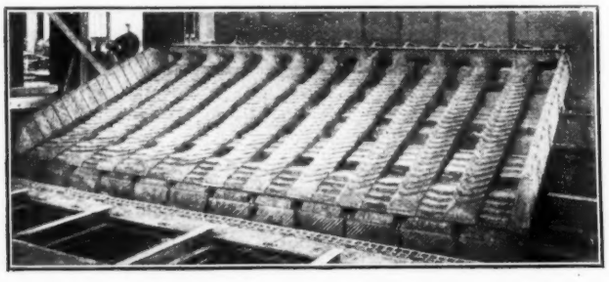


FIG. 5—NEW TYPE EXTENSION SIDE-WALL TUYERES

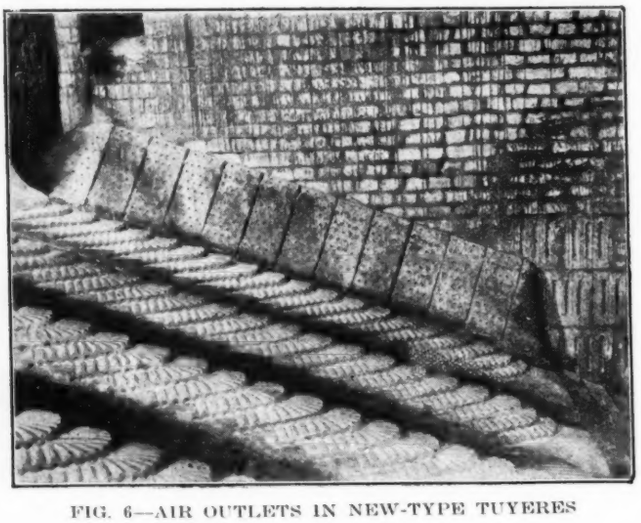


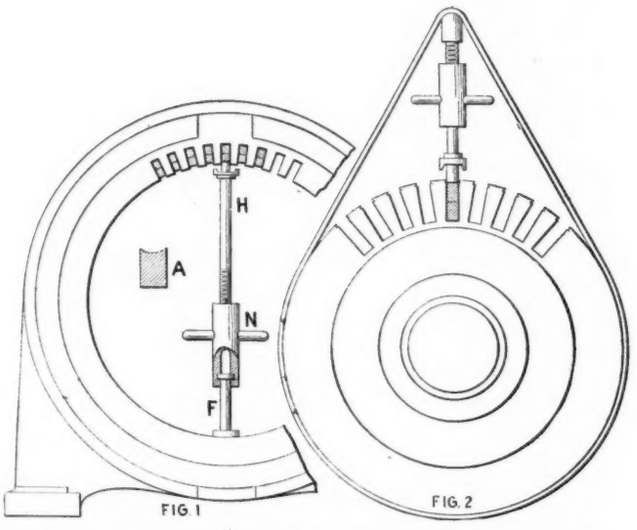
FIG. 6—AIR OUTLETS IN NEW-TYPE TUYERES

in the central portion of the furnace. The samples containing excess air were found consistently to be near the side walls. If some means were found to force this air to the central portion of the furnace, an improvement would be made to further assist in maintaining still higher combustion efficiencies.

The tables show CO_2 analyses of furnace gases taken at the bottom of the first pass.

Winding Device for Stators and Armatures

A patent, No. 1,431,819, has recently been granted to Henry Kleiber and Fred Mehr, Teaneck, N. J., on a device for placing coils in stator and armature slots of electric machines. One form of the apparatus is shown in Figs. 1 and 2. It consists essentially of a bearing head *H* and a foot *F*, one of which carries a



FIGS. 1 AND 2—SHOW HOW TOOL IS APPLIED TO PUTTING COILS IN PLACE

feed screw that can be manipulated with a nut *N* and cause the head and foot to separate. In Fig. 1 the device is shown as applied to forcing the coils in an alternating-current motor's stator in place. A slightly modified form, Fig. 2, is used in conjunction with a metal band in placing the coils on a direct-current armature. In the larger sizes the feed nut can be manipulated with a crank through beveled gears.

Where the coils fill the slots full, the equipment is of service in assisting to get the wedges into their places. By using a piece of fiber shaped as at *A*, Fig. 1, the edges of the slot insulation can be neatly forced down into the slot over the coil. There are many other purposes for which this tool will be found useful when winding electrical machinery.

Lead peroxide and sponge lead, which are the active materials in lead-acid storage-battery plates, are both excellent conductors of electricity, but lead sulphate, which is formed on discharge, is very poor in conductivity, in fact is an insulator. If the cell were allowed to fully discharge, so that all the active material on both plates was changed to lead sulphate, it would be practically impossible to pass enough current through the sulphate to recharge the battery. There is, therefore, a limit beyond which a battery must never be allowed to discharge. In this condition the amount of sulphate already formed is a relatively small portion of the active material remaining unconverted on both plates. The sulphate is so thinly distributed through the body of active material, which is of high conductivity, that the charging current is able to flow freely and thus convert the sulphate back to active material.

Taking and Recording Armature Rewinding Data

By A. C. ROE
Shop superintendent, service department, Westinghouse Electric and Manufacturing Co., Detroit, Mich.

FAILURE to secure proper data on armature windings is frequently the cause of mistakes being made when rewinding is done. Although in this article the author gives the method of taking these data in a large shop, the scheme can be applied equally well to the smallest plants.

ARMATURE winders have different methods and ways of taking and recording data for armatures that are to be stripped and rewound; some will mark the teeth on the armature core, while others mark the commutator bars. They all have different ways of putting this information on paper, often relying too much to memory and not putting important data down in black and white. These practices have frequently caused a great deal of trouble and unnecessary expense when rewinding direct-current armatures. To eliminate all the bad features and to incorporate all the good points of taking data, a card stamp and set of instructions were developed and used.

A rubber stamp, Fig. 1, was made up and each winder given a pad of stamped blanks. When an armature was stripped, the winder took the data and marked the armature as per instructions and put this information on the data sheet, which was turned in to the shop office, checked by the foreman and copied on the back of the shop card. The time taken for each operation—that is, strip and clean the armature, test and repair or remica the commutator, make coils, cut insulation, wind and connect armature, band, solder, dip and turn commutator, etc.—is put down day to day until the job is completed. The time for each operation is kept separate so that a record is had of each department. When the job is finished, this card is filed according to make and size of the machine, thus building up a permanent file of rewinding data and time for various types and makes of motors.

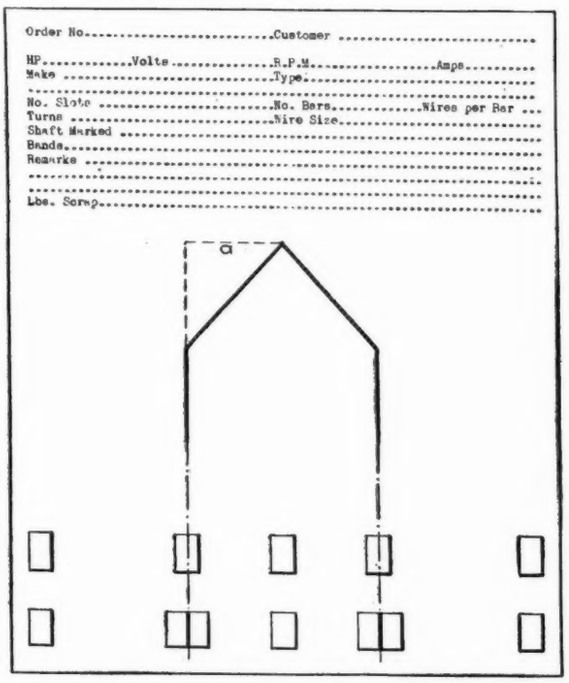


FIG. 1—FORM FOR RECORDING ARMATURE-WINDING DATA

The data required in Fig. 1 are filled in by the winder; the term "Wires per Bar" refers to the number of leads attached to each commutator bar and does not include any dummies or fillers. This is a check on the number of wires in hand required while winding the coils. That is, two wires per bar indicates one wire in hand for the same number of bars as slots; if twice the number of bars as slots, two wires in hand. If there are four wires per bar, there would be two wires in hand for the same number of bars as slots, and four wires in hand where there are twice the number of bars as slots.

Bands: After this heading, the number of bands, size of wire and width of bands are given. This is important, as in some armatures the core bands project into the air gap; that is, there are no band grooves, and if a heavy wire and clip are used, the air gap is decreased and in some cases the bands will rub the polepieces. Instructions to be followed in taking data on direct-current lap- or wave-wound armatures, are:

Mark the tooth each side of the slot that contains the top half of the coil, with two crosses (××), then put one cross (×) on the tooth each side of the slot that contains the bottom half of the coil.

Mark each commutator bar on the end, with a center punch, one dot, that contains a lead from the coil in the slots located by the cross marks.

Next line out from the center of the slot between the two teeth marked ×× to the commutator. If this line falls on the mica, mark one bar either side of the mica, with three center-punch dots. If the line falls on a bar, mark this one bar with three dots.

Mark the commutator bars on the center line of the slot between the teeth marked with one × in the same manner, except use two dots.

When the commutator is to be removed for repairs, do not mark it.

Always fill out data cards as per Fig. 1 on each job and mark armature as above.

If the armature has a dead coil or idle bar, use it for the locating marks, etc.

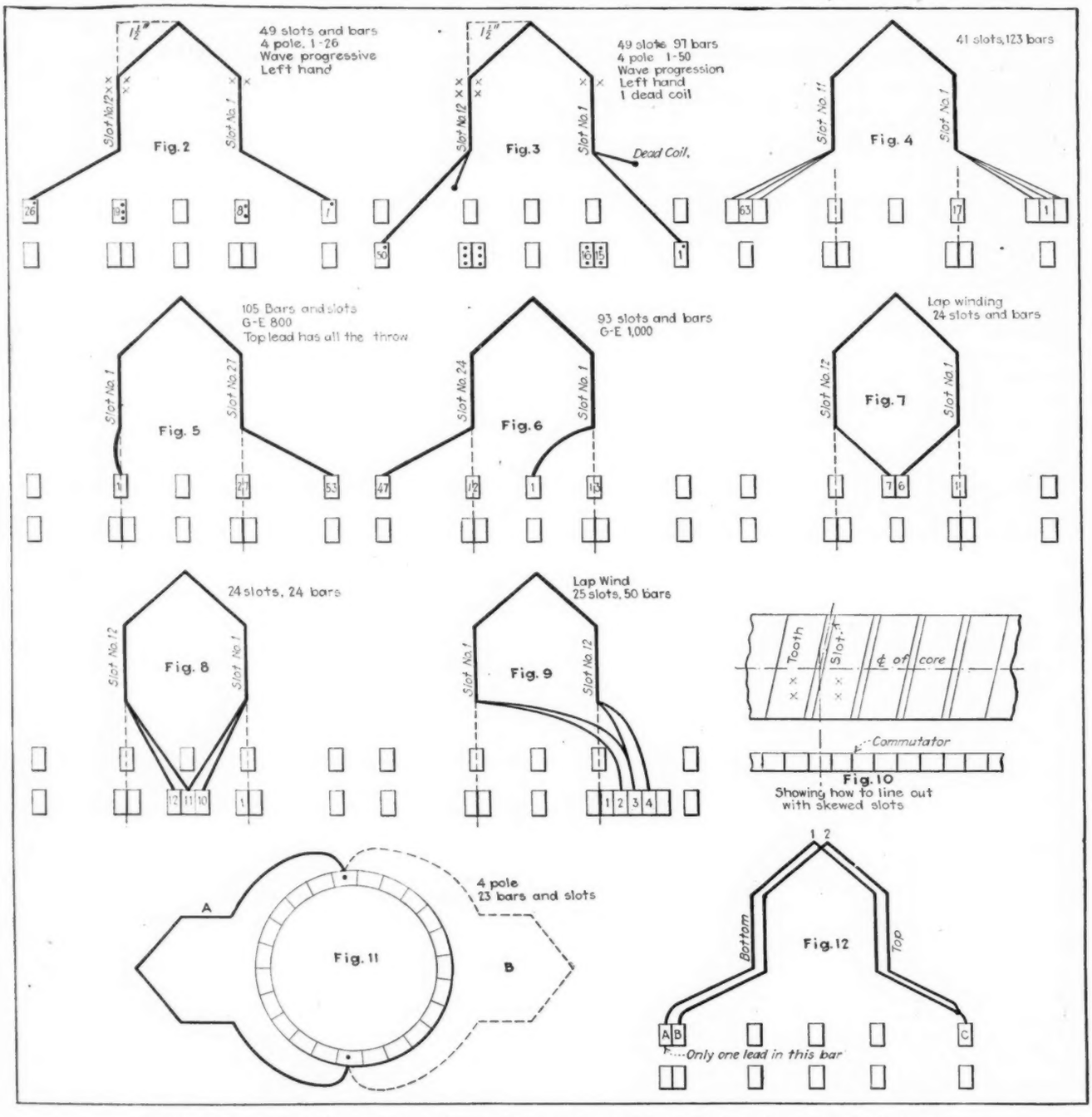
The reason that two crosses are placed on the teeth each side of the slot in which the top half of the coil lies, and only one cross to mark the bottom, as in Figs. 2 and 3, is to eliminate the possibilities of a right-hand coil being made instead of a left or vice versa, and this also preserves the correct coil pitch.

These markings save considerable time. That is, when a sample coil is brought down from the coil department to try out, there is no time lost looking up the data card to find the pitch, as it is shown on the core, and it also shows what slots to put the top and bottom halves of the coils in. Another saving is that the winder does not have to lay out his winding, as it is already done for him.

In large plants that maintain winding departments the time saved by making the core and commutator would be greater, since on repeated rewind jobs the markings would eliminate the necessity of re-taking data, and the armature could be stripped at once by the cheaper help.

The reason that the bars on the center lines of the slots, containing the first coil, are marked with dots, as in Figs. 2 and 3, is to eliminate the chance of connecting the armature up wrong. On most all four-pole wave-wound armatures there are two possible connections, long and short pitch, or progressive and retrogressive. Fig. 11 shows how it is possible to connect an armature wrong if only the top and bottom lead bars were marked.

The coil shown at *A*, Fig. 11, has a commutator pitch of 1 and 12, or short (retrogressive), which will be assumed as the correct winding. If the winder, when marking the bars, did not mark the slots nor the bars in front of the slots in which coil *A* lies, then when the armature was to be rewound there would not be any way of telling which was the correct commutater pitch.



FIGS. 2 TO 12—EXAMPLES OF HOW ARMATURE-WINDING DATA SHOULD BE RECORDED

Either the pitch of coil *B*, which is 1 and 13 long (progressive) pitch, or that of coil *A*, which is 1 and 12, may be used. If *B* was used, the direction of rotation would be reversed in a motor, or the polarity of the brushes would be reversed in a generator, from that obtained if *A* were used. This mistake could happen only on a four-pole machine; in fact, the four-pole winding is the only one on which either a long or a short pitch can be used at will.

This fact makes it possible at times to correct a winding mistake. Suppose that a set of coils were all made up right-hand instead of left-hand and that the armature was connected long pitch; then, instead of scraping the coils or changing the field connection, the armature could be connected with a short pitch, which would make things O.K., as using a right- instead of a left-hand coil, or a long instead of a short connection reverses the rotation, or brush polarity, therefore the one can be used to offset the other.

On motors having more than four poles, the connections cannot be changed to offset a wrong coil; hence, more care should be used while taking data and the armature should be thoroughly marked as indicated in Fig. 1 and the instructions.

Recording Winding Armature Data

The stamp shown in Fig. 1 was developed to apply to all types of windings, wave or lap, with one or more coils per slot, windings having a dead (idle) coil, or half idle bar, or with any possible brush position. In Fig. 1 the dotted line *a* connecting the end of the coil to the slot is to give the distance that the winding projects beyond the core. The two rows of squares represent commutator bars, the top row being used when the center line of the slots lines up on a bar, and the bottom line when the line-up is on line with the mica. When necessary, extra bars are drawn in and the lines drawn from the slot to the bars to show the number of coils per slot. In all cases slot and bar No. 1 are to be used to indicate the bottom half of the coil, and bottom lead in the diagram.

Figs. 2 to 9 show the stamp filled out for various types of windings. Fig. 2 is for a wave winding with the brushes on the center line of the poles; the bars marked 1 and 26 would have one dot on each, while bar 8 would have two; likewise bar 19 on line with slot 12 would have three dots. Fig. 3 is for an armature with 97 bars and shows how the dead coil is indicated. Fig. 4 is for an armature having three times as many bars as slots.

When the number of coils per slot is even—that is, 2, 4, 6, etc.—use the right-hand side coil for showing the pitch and other details. When the number is odd, use the middle coil, as in Fig. 4.

Fig. 5 shows how the card is filled in for a winding with all the throw in the top lead, right-hand. Fig. 6 shows the data for a G.E. 1,000 armature; note how the bottom lead is brought over to the center line of the coil and the manner in which this lead is located. Figs. 7, 8 and 9 are for lap-wound armatures, and show how the stamp can be used for the small hand-wound types. When taking data on armatures having skewed slots, line out from the center of the core, as in Fig. 10, and not from the commutator end of the slot.

Fig. 12 shows how an armature with half idle bar is connected; that is, 49 slots and 98 bars. Instead of there being a dead coil, bars *A* and *B* are made as one, by forming a long jumper of the coil. The top leads of coils 1 and 2 are soldered together as shown and connected to bar *C*, then the bottom lead of coil 1 is put in bar *A* according to the proper connecting data. The bottom lead of coil 2 is put in bar *B*. The slot in the neck of bar *A* should be filled with dummies after putting down the bottom lead of coil 1, and this is the only lead connected to this bar, thus making the equivalent of a 97-bar commutator.

European Oil Engines

Discussion of Correct Air-Oil Mixing—The Deutz Engine—New Hesselman Solid Injection Engine

By Edvin Lundgren*

ONE of the factors that exert a great influence upon the proper combustion in an oil engine is the state of motion of the air in the cylinder, or its turbulence. Although the importance of this factor has only comparatively recently been realized, its possible influence was demonstrated ten years ago by Sir Dugald Clerk in a very striking manner. While many of the readers of *Power* very likely are acquainted with this test, it deserves to be called to attention once more.

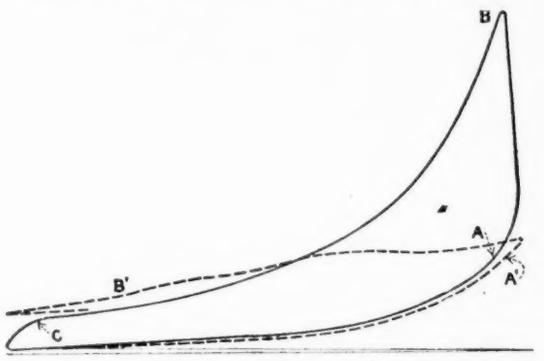


FIG. 1—DIAGRAMS OF CLERK'S EXPERIMENTS

Clerk made his experiments with a horizontal gas engine in which the ignition could be cut out and the inlet and exhaust valves could be kept closed at any time during the running. If the gaseous mixture was allowed to expand and to be compressed a few times before the ignitor was thrown in again, the expansion curve obtained by the indicator when the mixture was ignited had quite a different aspect from the normal combustion and expansion curves.

Fig. 1 shows the normal pressure rise *AB* and expansion curve *BC*. The broken line curve *A'B'* was that obtained by ignition after the third compression. According to Clerk's apparently well-founded opinion the striking difference was due to the fact that the gaseous mixture remaining in the cylinder during a few strokes had almost entirely lost its turbulent motion, which is invariably possessed by the fresh charge entering through the relatively narrow passages of the inlet valves, or ports in the case of a two-stroke-cycle engine. The explanation is plausible enough. In a gas mixture the small particles of which have come to a rest, the flame is propagated with a considerably slower speed than in a mixture in which all the particles are in a turbulent motion. On account of this slow flame propagation the rise of the temperature and the pres-

*Consulting engineer, Stockholm, Sweden.

sure due to the combustion may be so slow that it is entirely compensated by the enlargement of the combustion space by the moving piston. The results of the tests made by Clerk have been corroborated by experiments conducted by Hopkinson.

In an oil engine the motion of the air is of still greater importance than in a gas engine, as only the motion of the air makes it possible for each minute oil drop to find its proper quantity of oxygen in the air. Utilizing this knowledge, it has been possible to dispense with the use of compressed air for fuel injection in high-pressure oil engines. Thus in the solid-injection engine manufactured by the Deutz Company, of Germany, this is accomplished by providing the piston with an extension which protrudes into the combustion chamber in the cylinder head shortly before the piston has reached its inner dead center, as outlined in Fig. 2. The piston extension fits into the combustion chamber with a very small clearance, and when it enters the cylinder head the greater part of the air is still in the cylinder, but as the piston proceeds further this air is forced through the narrow clearance between the piston extension and the cylinder head. The air attains a high velocity, and the whole air content of the combustion space in the cylinder head is set into a violent motion. By a small ridge on the piston head the motion of the air is deflected into certain desirable directions. The consequence is that the minute oil drops which, by the action of the fuel pumps, are injected into this air, are most thoroughly and evenly distributed, and a good combustion is feasible within the available short time.

A similar idea has been applied by some English concerns, by the French Peugeot Company and by at least one American concern.

The air should not, however, be set into any uncontrolled and unlimited motion, but should obtain such a deliberately designed motion as to distribute the oil in the most effective manner. All the factors that might exert any influence in this respect have been most carefully studied by K. J. E. Heshelman, of Stock-

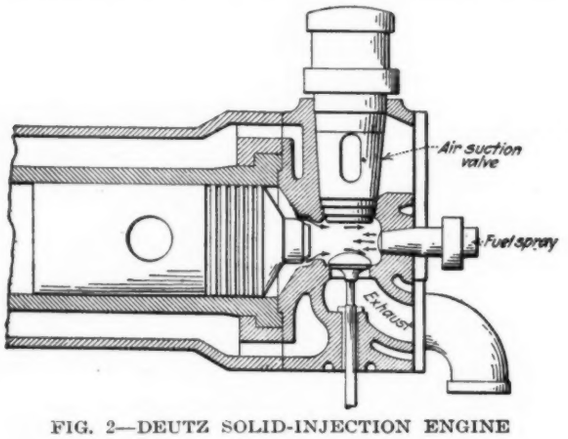


FIG. 2—DEUTZ SOLID-INJECTION ENGINE

holm, Sweden. The results of his investigations, which were guided by a singularly long and universal practical experience with Diesel engines, have been embodied in the design of a new high-pressure oil engine with mechanical injection. The experimental engine of 65 hp. has achieved a remarkably good fuel consumption.

Fig. 3 shows a section and a plan view of the combustion space of this engine. The fuel nozzle is provided with a limited number of fine openings; as a rule five holes are used. The combustion space is of unique shape, which was chosen after many experiments and investigations of the penetrating power of the minute oil drops. By means of a shroud on the inlet valve cage the incoming air is guided in one certain

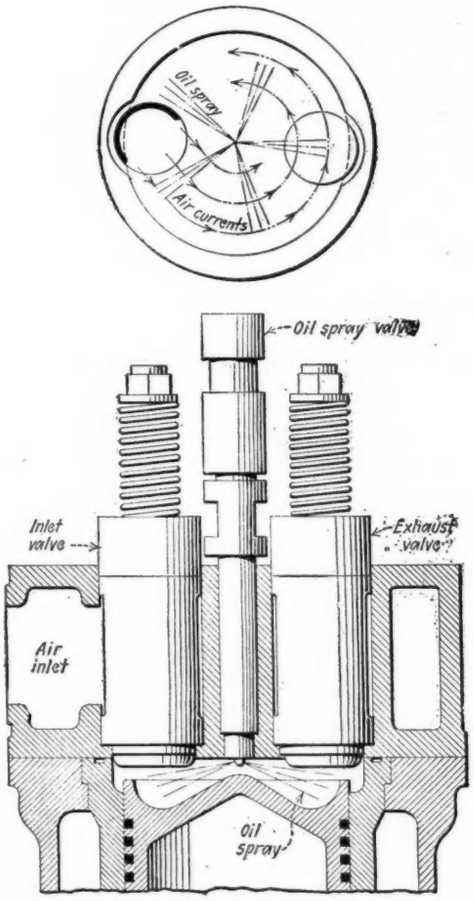


FIG. 3—ARRANGEMENT FOR MIXING THE AIR AND OIL IN THE NEW HESSELMAN OIL ENGINE

direction as indicated in the plan view, so that the whole charge is given a rotating motion which continues during the following compression stroke. This rotary motion of the air and the annular shape of the combustion space have been found to be of great importance. There are of course other features in the engine which have contributed to its success, but in this discussion only the part played by the turbulence of the air has been mentioned.

It has been estimated that 90 per cent of the work done by the brake when stopping a single-speed alternating-current elevator is that necessary to overcome the kinetic energy of the rotor. This is not hard to understand when it is considered that the action of load, car and counterweight at the brake wheel must be transmitted through the worm gear where a large amount of this energy will be dissipated, while the energy of the rotor is presented at the same shaft upon which the brake wheel is mounted. This accounts for the breaking of rotor shafts when the stopping is too abrupt, as the force exerted upon the rotor is increased very rapidly as the time of stopping is decreased. In the two-speed machine a large percentage of this energy is absorbed in the electric system.

Governing Devices of British Steam-Extraction Engines

THE usual steam-engine governor is unsatisfactory when steam is bled between stages of a compound engine. In this discussion the methods whereby satisfactory regulation is obtained on British engines are dealt with.

THERE are many industrial processes in which considerable steam is used apart from that required for operating the machinery or power generation.

This dual demand for steam does not always lead to economical working, especially when the fluctuating loads on both systems are not balanced automatically. To effect the most economical working of a plant from which steam is required for power and for use in such places as paper works, breweries, dye works, chemical works and textile factories, what is known as the pass-out or steam-extraction engine is undoubtedly a valuable asset.

Externally, these engines have much in common with the well-known slow-speed horizontal engine of the poppet-valve pattern, the unaflow engine being well adapted to the purpose. Single cylinders are used in many cases, compounding being resorted to for larger powers, although working these engines compound tends to complicate the governing somewhat, as will be shown later. The fact that the unaflow engine is essentially a single-cylinder engine renders it especially suitable for cases where the whole of the exhaust steam is used for "pass-out" purposes.

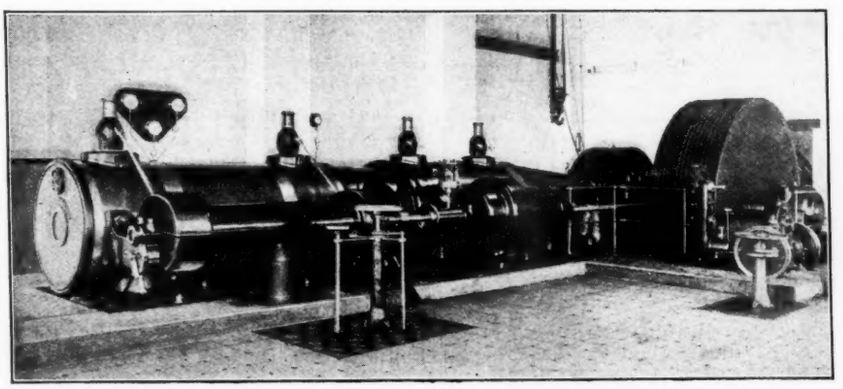


FIG. 1—BRITISH STEAM-EXTRACTION ENGINE

Of course there is nothing novel in using exhaust steam for manufacturing purposes, but the conditions under which the ordinary steam engine works are not favorable to the economical working of the dual system. Unless some regulating device is introduced, it is difficult to control the load on the engine so that the exact quantity of steam is admitted to and exhausted from the engine, and in nearly all cases wasteful working must result because any shortage of exhaust steam must be made up by live steam reduced in pressure.

The engine shown in Fig. 1, which is a British production, is of the Cole, Marchant & Morely standard design arranged to supply exhaust steam between stages. Steam is extracted at constant pressure from the receiver after doing the work in the four-valve high-pressure cylinder, the pressure being automatically regulated by a patented device. Any surplus steam passes to the low-pressure unaflow cylinder. The normal indicated horsepower is 530, while 4,000 to 8,000 lb. of steam per hour at 10 lb. pressure is extracted, the working pressure being 160 lb. per sq.in. and the speed, 150 r.p.m.

Where steam-extraction engines differ from the orthodox condensing type is in the valve gear and the governing. Both are modified to suit the peculiar conditions of working. In order to insure the most economical operation, the valve gear is designed to balance the load on the two sides of the piston at all times. With the single-cylinder engine it is usual for one side of the piston to exhaust into the pass-out system and the other into the condenser. The governor, then, must be arranged to admit into one end of the cylinder only just that quantity of steam required by the pass-out system. When a sudden demand for steam comes from the latter, an arrangement of the valve gear automatically lengthens the cutoff in this end of the cylinder and at the same time reduces it in the other, thus maintaining the engine speed and load capacity. When no heat at all is being abstracted, the engine exhausts wholly to the condenser. For the single-cylinder engine the usual drop-valve system is employed for the admission and either similar valves or a central outlet for exhausting. These valves are operated by the usual eccentric system from a revolving layshaft, the inlet being under the control of some form of gear operated by a speed governor. The exhaust steam and power load are balanced by an arrangement controlled by the variation of pressure in the heating mains. In the Atlas engine having one cylinder, arrangements are made whereby the eccentric positions for each half of the cylinder may be varied independently, but both are simultaneously governed by the speed governor. In conjunction with the latter, which may be termed the primary governor, is a pressure-operated, or secondary, governor. In the event of an increase of the power load causing an excess of pass-out steam, this secondary governor exhausts any surplus steam from the pass-out end of the cylinder into the condenser.

When the engine is compounded, the governing becomes a highly technical business. In the case of the simple engine. if no steam is going to the pass-out system the engine simply exhausts wholly to the condenser or to atmosphere if there is no condenser.

On the other hand, with a compound engine much depends upon where the extraction arrangement is located. It may be taken from between the two cylinders and, if necessary, reduced in pressure. The lower-pressure cylinder would then run condensing. On the

other hand, steam at two different pressures may be taken from the receiver and the low-pressure cylinder. This is merely a matter of individual requirement, but is one that demands careful attention in the choice of the engine.

Two governors, a speed or primary, and a pressure or secondary one, must be installed, one for each cylinder.

The primary governor for the high-pressure cylinder follows the usual system for speed governors of the sensitive type, but the secondary one is pressure operated. To maintain the pass-out steam at a constant pressure, it is not sufficient simply to govern the cutoff in the high-pressure cylinder of a compound engine, because the later the cutoff in this cylinder the higher will be the receiver pressure irrespective of the terminal pressure. It will be apparent that the governing of these engines presents a problem that cannot be undertaken lightly. It is a matter that requires the most minute attention at the hands of the designer, as apart from a

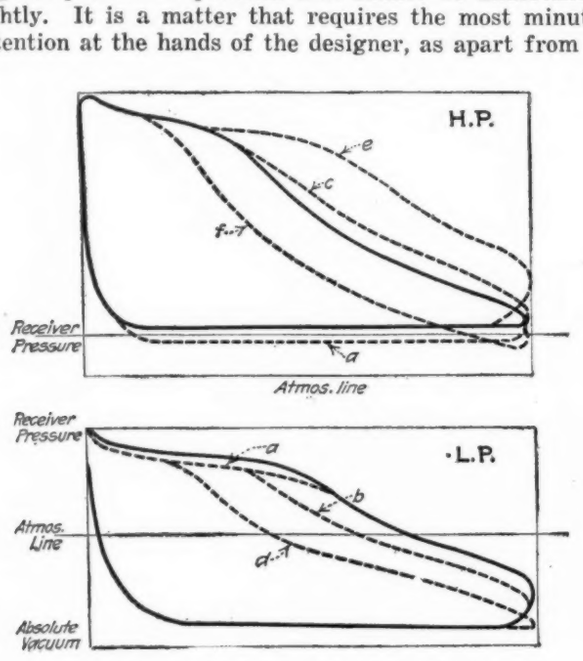


FIG. 2—GOVERNOR ACTION OR CHANGE IN STEAM REQUIREMENTS

suitable engine with suitable valve gear the governing system plays the main part in the economical operation of the whole.

The conditions in the compound pass-out engine are best understood from a study of the indicator diagrams as shown in Fig. 2. In this case the valve gear of the high-pressure cylinder is under the control of the primary governor, giving a cutoff from 0 to 70 per cent. The valve gear of the low-pressure cylinder is under the control of a secondary governor and cutoff depends upon the pressure in the steam-extraction piping. The full lines refer to working conditions where no steam is extracted. Any demand from the pass-out system, either as a first extraction or an increase above normal, will cause a momentary fall in the receiver pressure as indicated at *a* on the high-pressure diagram and at *a*, the steam line, of the low-pressure diagram. It is the duty of the primary governor to make the low-pressure cutoff earlier, giving the expansion line *b*. This brings the receiver pressure back to normal. In the meantime, however, the reduced admission in the low-pressure cylinder tends to slow up the engine, and this is counteracted by the primary governor increasing the steam admission to the high-pressure cylinder as shown at *c*. Thus both speed and power are returned to normal. The curve *d* shows that still less steam is being admitted to the low-pressure cylinder, owing to increased draw-off from the receiver, while curve *e* shows an increased admission to the high-pressure cylinder, indicating that the power developed is being maintained at a constant amount.

The limit of extraction from the receiver is reached when the cutoff in the low-pressure cylinder is at 2 per cent; this is the minimum to permit of the necessary drifting steam, but the maximum amount of steam can be extracted only when the quantity admitted to the high-pressure cylinder is sufficient to maintain the power that is required to be developed by the engine. If the power and extraction loads on the engine change at the same time, the primary and secondary governors must adjust themselves to one another to maintain the essential conditions. Curve *f*, Fig. 2, shows the state of affairs when there are very small power and extraction demands, the looping denoting negative work. Such conditions must be avoided as far as possible, the relief valve being generally adopted as an efficient way of dealing with this. Of course there may be conditions where the receiver would be unable to supply the maximum quantity of extraction steam at times; in this case there is no other alternative but to supply the deficiency in the shape of live steam through a reducing valve. This valve would be under the control of the secondary governor and would operate only when the cutoff in the low-pressure cylinder is adjusted to admit the minimum amount of steam. Some designs provide an emergency safety governor to reduce the admission to the low-pressure cylinder if the engine speed rises above normal due to the load being very low. It is generally considered preferable to a non-return valve in the extraction steam piping, which is sometimes installed for the same purpose.

When it is necessary to extract steam from the receiver and from the low-pressure exhaust, the primary and secondary governor systems are employed. Under these conditions, however, it is impossible to maintain both receiver and exhaust pressures constant by adjusting the amount admitted to the low-pressure cylinder. If the receiver pressure is to be maintained at a constant level, the secondary governor is controlled by the pressure in the pass-out piping, and none of this steam should be blown off. If the low-pressure steam is deficient in quantity at any time, it must be augmented by live steam through a reducing valve whose operation is independent of the engine. If, on the other hand, the low-pressure exhaust pressure is to be kept constant, the secondary governor is under control of that pressure, a safety valve being fitted in the low-pressure exhaust pipe. When the extraction from the low-pressure exhaust is below normal, there is no other option than to blow it off through this valve, and as the maintaining of a constant low-pressure exhaust pressure is bound to be more or less wasteful, such conditions should not be called for unless absolutely essential. A better arrangement is to combine a compound engine with a single-cylinder back-pressure engine. The former is governed in the way described, the receiver pressure being kept constant, while the latter works as an independent unit. In fact, by combining two such engines a wide variation of conditions can be satisfied, and as further experience is gained in what after all is a comparatively new development in steam-engine practice, it is likely that the steam-extraction engine will have a wide field.

Blocking an Emergency Governor Out of Service Results in Turbine Wreck

INVESTIGATIONS have been completed regarding the loss of a 1,500-kw. turbo-generator at Hibbing, Minn., a brief report of which appeared in the Nov. 28, 1922, issue of *Power*. The unit was fully covered by insurance and the manufacturer was in no way held responsible, a duplicate unit having been ordered for replacement.

Overspeeding of prime movers and low water level in steam boilers are familiar causes of disastrous wrecks, which will undoubtedly occur at intervals as long as such machinery is extensively required for human purposes; devices for preventing these catastrophies are subject to deterioration, neglect, or to being purposely placed out of use for apparently good reasons. Unusual conditions in this particular instance led to blocking the emergency governor out of service. Unfortunately, the hastily formed judgment here resulted in destruction, pointing to the soundness of the old moral of placing considerations of safety above those of continuity of service and all other factors irrespective of their apparent relative importance.

A 1,500-kw. automatic bleeder-type turbine had been operating for two months in the municipal plant at Hibbings, Minn. This was carrying the entire station load, approximately 1,350 kw., bleeding steam at about 5 lb. gage into the heating system. Two other 300-kw. units completed the station equipment.

It is reported that the trouble started at 4:10 p.m. with sudden loss of vacuum which caused a reduction in the turbine speed. The one operator on duty in the engine room, being close to the turbine and some distance from the switchboard, immediately shut off the supply of steam to the heating system, started the steam-driven auxiliary oil pump, and then went to the switchboard and pulled the turbine off the line. The steam-driven exciter and one of the 300-kw. bleeder-type turbines in the station were then started and put into service. It was necessary to do this because both the exciter and the circulating pump on the condenser of the 1,500-kw. unit were motor-driven.

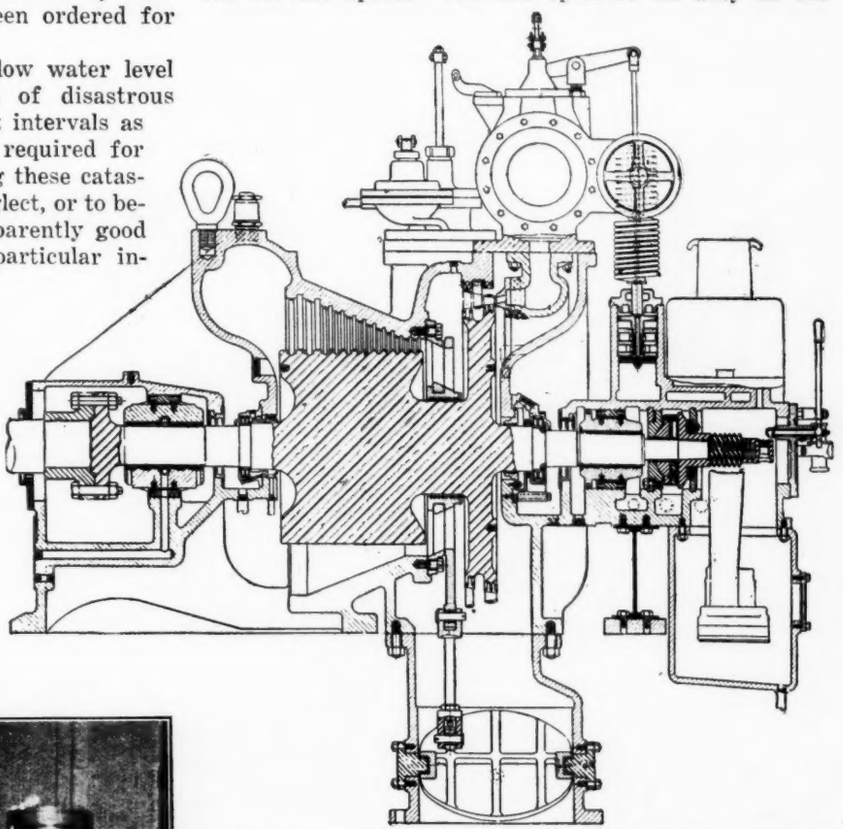


FIG. 2—CROSS-SECTIONAL VIEW OF 1,500-KW. TURBINE

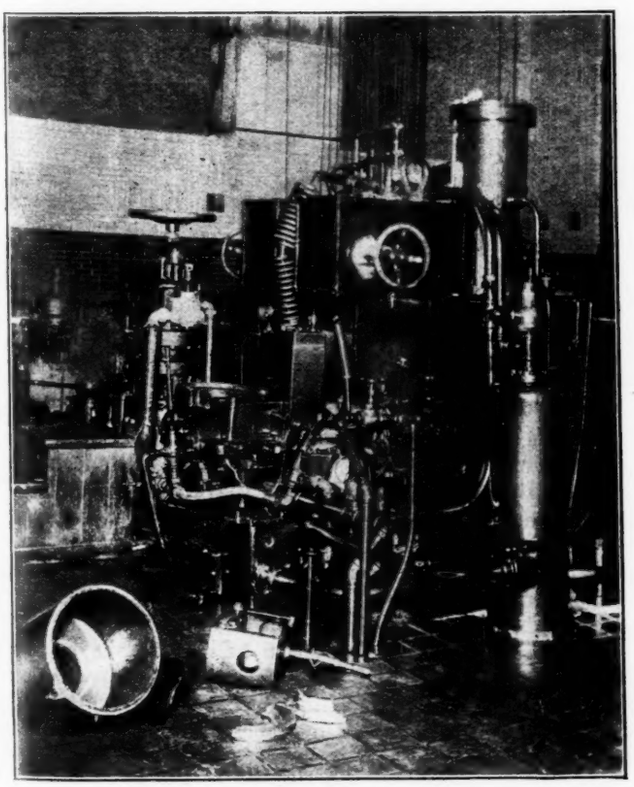


FIG. 1—TURBINE END OF WRECKED UNIT

An assistant, believed to be stationed on the condenser floor, succeeded in re-establishing the vacuum and the turbine was again put on the line, but the vacuum again quickly failed. This cycle was repeated several times without discovering the cause of the loss of vacuum, and meanwhile the automatic overspeed stop on the turbine functioned several times, the cause of which apparently was not investigated or corrected.

At 5:30 p.m. a second operator came on duty and immediately assisted in putting the turbine back into service. To avoid any further annoyance an account of the automatic overspeed stop functioning, the hand valve in the steam line between the stop-governor relief valve and the operating trip cylinder was closed,

thereby making the safety device inoperative. On this type of emergency valve gear the trip releases steam from an operating cylinder which automatically closes the inlet valve and main hand throttle valve.

It was evidently the operator's opinion that the stop was functioning at or below the normal operating speed. Further attempts were made to parallel this machine with the 300-kw. unit which was in service. While this was going on, the attendant stationed at the switchboard observed the frequency increase from 60 cycles to 75 cycles, which was the limit of the instrument. He shouted to the operator of the turbine to shut it down, but before this was done the wreck occurred. This was approximately 1½ hours after the trouble started.

The recording watt-hour meter chart indicates that the 1,500-kw. turbine was on the line for short intervals, as there are loads reported in excess of the capacity of the smaller unit. Apparently, excessive vibration at the time of the accident shook the automatic throttle valve shut because no steam escaped into the engine room, although the turbine cylinder was broken. No one was injured.

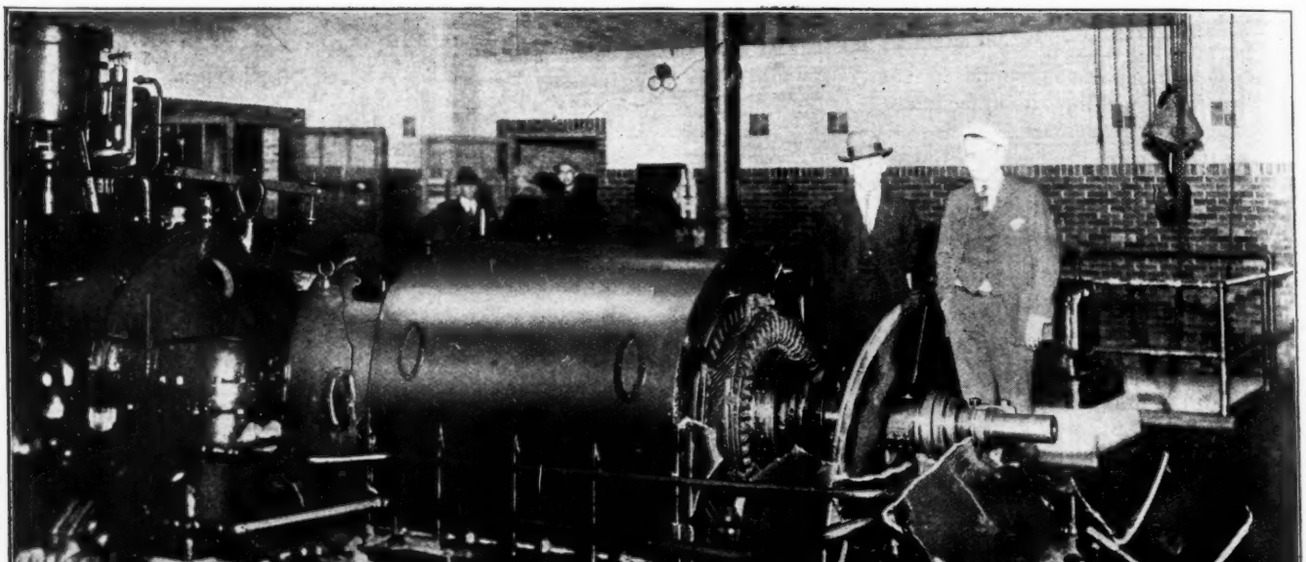


FIG. 3—VIEW FROM THE GENERATOR END

The completeness of the wreck, together with the absence of personal injury or appreciable property damage, is quite remarkable. The entire governor case and main bearing housing was torn loose and forced out of position vertically about six inches, parts of the governor were broken and thrown several feet from the turbine, while the turbine rotor shaft end which carries the overspeed governor and the main governor drive worm was broken off between the thrust bearing and the main bearing. The turbine cylinder at the exhaust end was broken, including the ribs which support the middle bearing, the latter being broken in halves.

The parts of the rigid flange coupling between the turbine and generator were intact, including the flange bolts, but the generator shaft end, which was pressed into its coupling half with a heavy press fit and amply keyed, was wrung entirely out of the coupling. The generator end bells, frame and rotor were somewhat damaged; the outboard generator pedestal and bearing were broken, and the generator rotor was forced endwise away from the turbine several inches. The generator blower vanes were distorted in a manner indicating excessive overspeed. The top of the foundation around the holding-down bolts was slightly damaged as a result of the excessive vibration.

From an examination of the unit it appears evident that the wreck was a direct result of excessive overspeed throwing out the low-pressure blading. This was followed by a violent vibration, causing breaking of the governor shaft and due to whipping and interference of the governor worm and wheel, teeth of the latter were badly crushed. The vibration accompanied by end thrust broke the middle bearing and its housing including the adjacent portion of the turbine cylinder; whipping of the shaft at this point forced out the generator shaft from its coupling and damaged the generator and outboard pedestal and bearing.

Evidence is lacking as to the cause of the turbine's repeated overspeeding, as well as to the exact mechanical condition of the machine at the time of the accident. The unit had been in regular and satisfactory service for two months. It was reported that the balance of the rotating elements was so good that a coin would remain standing on edge on any part of the machine, including the governor housing.

Loss of vacuum was found to be due to one of the gland water supply pipes being partly clogged with foreign matter. The repeated overspeeding and functioning of the automatic overspeed mechanism must have been due to some temporary sticking of the governor-controlled inlet valves or some undiscovered disorder of the governor mechanism.

Does the "Air Lift" Push or Pull the Water?

By FRANK RICHARDS

DOES the "air lift" push or pull the water? It does neither, and this is to tell something about it. Some time ago I remarked, not entirely without thinking, that the name "air lift" is not correctly suggestive of the characteristics and mode of operation of the device to which it is applied. At the same time I remarked also that apparently no one has been able to supplant the name with anything better.

The unsatisfactory circumstance here is not alone in the name. Back of it is the wide lack, even to this day, of a correct understanding of the air lift itself and of how it really does its work. Dr. Pohle, we know, had very vague and mistaken ideas about it, and some of the descriptions and claims in his patents were absurdities which competent Patent Office examiners should not have allowed and which never could have been sustained in law. Whether he ever came to a clear and complete understanding of the invention or discovery that bears his name, we may not know. Today there are plenty of engineers who thoroughly understand the air lift and are competent to advise as to its employment under any conditions that may be proposed, and for them, of course, these words that follow here are superfluous.

THE author of this article is particularly fortunate in having, along with an exceptional knowledge of compressed-air technology, the ability to explain things in simple non-technical language. During his thirty years of intimate contact with this field of work, Mr. Richards has written two books and many articles on compressed air. For twelve years he was editor of "The Compressed Air Magazine," with which he still maintains a connection. Tbe present article is a remarkably simple explanation of the principle upon which the air lift operates.

Too many who attempt an understanding of the air lift are misled by their own gratuitous assumption that there is something mysterious or confusing about it, whereas it is, both in arrangement and operation, one of the simplest things ever known, as the sketches herewith—showing the essentials of the air lift—should enable us to see.

It is to be remembered, in referring to the sketches, that an actual discharge pipe might be fifty times or perhaps a hundred times as long as here shown in proportion to the diameter, and the air bubbles might not be crowded or uniformly distributed, but the principle of operation will be suggested and understood just the same.

We have here, then, a well or a body of water which, for our present purpose, is inexhaustible, so that it will remain at constant level no matter how much may be taken from it by our air lift. In this water stands vertically a water discharge pipe of sufficient diameter and fully open at both ends. The upper end is at the height to which we propose to lift and deliver the water, and the other end extends for a considerable distance down into the water. There is also a pipe for the delivery of the compressed air, so placed that the bubbles of air as they emerge will be distributed in and will mingle with the water in the discharge pipe a little above its lower extremity, and will naturally have no way of escape except as they, as we may say, float upward through the water. These two pipes constitute the entire air lift and are ready for business as they stand. We assume, of course, that there is a constant supply of compressed air at the required pressure, with a valve to regulate and control the air flow. And that is all. Was ever a simpler arrangement known for any reliable service?

At the beginning or just before the beginning of the operation of elevating the water, it stands at the same height in the discharge pipe as in the body of water outside the pipe, the column of water in the pipe having at the bottom of the pipe the same pressure as the water surrounding it without the slightest tendency to flow in either direction. If no attention has been paid to the air pipe, there is water in that also, and when the air pressure is admitted, this water is driven down and out to mingle with the general body of water.

The pressure of air required will be determined by the vertical height of the standing water level above the point where the air will begin to escape, this pressure being 0.4335 lb. per square inch for each foot of height. This starting pressure, with a slight excess to cause the flow, will be the greatest pressure required or which can properly be used to operate the air lift. If the water level outside the discharge pipe falls appreciably when the air lift is in full operation, the usable air pressure will be proportionately reduced, but that we have nothing to do with here.

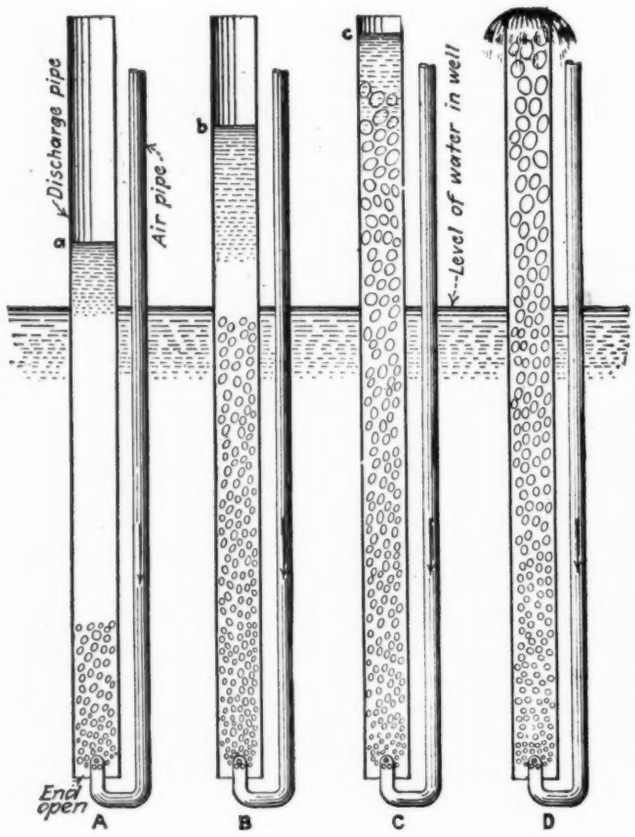
When the water in the air pipe has all been driven out and the air begins to escape, it naturally distributes itself in the form of bubbles mingled with the water. As the column of water in the pipe weighs precisely the same as before, the weight of the air being so slight as to be negligible, and as the distribution of the air bubbles in the water has considerably increased the total content of the column, this increase of volume results in the rise of the top of the column to make room for it, and we may assume that the water, the same water without any addition, rises to *a* in the discharge pipe *A* as shown. This is not in any sense a lifting of the well water, since no additional water has flowed into the discharge pipe from the well. The original column of water has simply been elongated upward by the presence of the air bubbles.

At *B* we have precisely the same condition as at *A* with simply more air bubbles and a greater vertical elongation of the water column, the top of which now extends to *b*, but still with the same volume of water in the pipe as at the beginning.

At *C*, by the accumulation of more air bubbles, the same column of water has been so elongated as to reach

almost to the top of the pipe, or to the point of ultimate water discharge. Before this discharge occurs, or the actual operation of the air lift begins, it will be well for us to look a little more closely into what has been going on.

We have to notice how inert the air has been all through, how little it may be said to have done. Its mere presence in the water may be said to have been all that was required. It is forced into the water column at the bottom by the pressure of the air behind it, this backing-up pressure extending all the way back to the compressor, and when the air is driven into the water column it simply floats upward, bubble by bubble. Even this floating must be credited not to the



SHOWING THAT THE "AIR LIFT" NEITHER PUSHES NOR PULLS THE WATER

bubble itself, but to the continued reflow of the water down under it, because in all cases of flotation the heavier body, in this case the water, continually slips under and pushes the lighter body above it clear to the top.

This constant rising of the air bubbles through the water and the relative slipping back of the water goes on when the column of water is in motion and the air lift is in full operation just the same as now before the column has begun to move, and this slippage is regarded by air-lift experts as the chief source of loss of efficiency in the air lift. It is curious, however, that without this slippage it would apparently be impossible to start the air lift at all, for by what other means would it be possible to get the air bubbles distributed all up through the water?

It is to be noted that the air bubbles, as they rise through the water, are subjected to a constantly diminishing external pressure on account of the decreasing height of the water above them in the column and, with the reduction of pressure from the liquid which encloses them, they correspondingly expand and are much bigger when at the top and about to escape than they are at the bottom. In this particular the air is not as inert as was previously asserted for it, and all the expansion that occurs counts effectively in the lift, for the bigger the bubble the greater the displacement of water and the greater the levitating effect. The expansion being practically at constant temperature, the resulting volume is greater than if it were adiabatic. The benefit of the expansion of the air in use is apparently as fully realized in the air lift as in any of the various employments of compressed air.

In the preliminary aërating and levitating of the column of water in the discharge pipe, at the beginning of the air-lift operation, the events will not be so smooth and orderly as suggested by the sketches or by the attempted description. The bubbles will be each one for itself; some will rise faster than others, some will unite to form bigger bubbles; the water surface will be broken and agitated. When the water column has nearly reached the top of the pipe, as at *C*, it is quite possible that some of the more enterprising of the bubbles have already risen through and escaped. A little more rapid delivery of the air with a little greater total displacement of the water in the column by the accession of air and it will rise at once above the top of the pipe and overflow. This instantly lightens the column, water begins to flow into the bottom of the pipe, the entire column rises and the air lift is at work. An increased delivery of air will accelerate the movement, and in a short time a uniform delivery will be attained and maintained until conditions are changed.

It should not be necessary to say more here as to the principle and the routine of operation of the air lift to maintain our proposition as to its simplicity and understandability. At the same time its simplicity should not mislead us as to its specific and precise requirements in the practical employment of it. Anyone should be able to make an air lift that will work, but to make an air lift that will work satisfactorily and economically and whose capacity will fit the requirements, calls for an expert. Experiments are costly, and failures are to the inexperienced far from suggestive of the remedy.

The most valuable data of all are found in the records of daily operation. A special test shows what can be done for a short time and under special conditions. An operating test, extending over weeks or months and including all the daily losses of stand-by and every-day operation shows conclusively whether or not the plant is well operated. The minimum requirement for obtaining such figures is apparatus for giving a continuous record of the weight of coal fired and of water evaporated. For accurate results the coal must also be sampled at regular intervals and tested in a bomb calorimeter for heat value. If the feed temperature and steam pressure vary much, they should also be recorded. By keeping these records, the average efficiency for each week or month can be figured from the total weight of water evaporated, the total weight of coal fired, the average steam pressure and the average feed-water temperature. This will show exactly *what* the plant is doing. To tell the *why* of low efficiency use must be made of CO_2 machines, pyrometers, steam meters, etc. With the aid of these, bad conditions can be corrected.

The Super-Synchronous Motor for High Starting Duty

By W. L. MERRILL
Engineer, Power and Mining Engineering Department, General Electric Company

SEVERAL factors have contributed to the prominence which the economical and electrical advantages of the synchronous motor for machine drive have attained in the minds of engineers, and to the increasing desire to realize the effect of these advantages on power bills and plant operation generally. One of the more influential of these factors is the growing tendency of power companies to insert penalty-bonus clauses in their power contracts. This makes the comparative power factors of synchronous and induction motors, especially on applications requiring slow-speed drive, a subject of considerable interest to large users of power. Therefore, although handicapped for many applications, the synchronous motor is in many instances replacing the induction motor for direct-connected drive.

The principal one of these handicaps is the necessity of using clutches between the motor and the driven machine, and is imposed by the low starting and pull-in torque that is characteristic of synchronous motors. The necessity of using clutches has constituted a limitation for several reasons, chief among them being the large amount of space taken up by the clutches and their bearings, the increased maintenance charges and the necessity for the accurate aligning of the motor and the driven machine. A synchronous motor has been recently designed and built by the General Electric Co. with such starting characteristics as to remove these limitations, that is called the "super-synchronous motor." It has shown on test that it will develop a torque of from 150 to 200 per cent of normal throughout the starting period, as the torque available at the shaft is equal to anything below the pull-out torque of the motor and is proportional to the current. While the construction of the new motor embodies certain features that have been used successfully on other apparatus, the electrical and mechanical principles of its operation are sufficiently novel to be interesting.

In appearance the new synchronous motor somewhat resembles those of ordinary types, with the exception that the frame is equipped with a band brake similar to those on mine hoists (see Figs. 1 and 2). As to operation, in starting, the brake is released and current admitted to the armature, which is free to revolve, bringing it up to synchronous speed regardless of the load. During this period the field is held stationary by the friction of the load, to which it is directly connected through a coupling. When the armature is at synchronous speed, current is admitted to the field, as in the ordinary synchronous motor, and the brake is gradually applied manually to the armature frame. As the latter slows down, the field and its load are brought gradually up to speed, until, with the armature locked stationary by the setting of the band brake, the motor is functioning as a conventional synchronous motor. One of the additional advantages of this method of starting directly driven machinery is the smooth acceleration of the load that is made possible, whereby the driven machine is saved from any shocks in starting.

The brake itself is designed along lines that have been established as the result of long experience with brakes used on mine hoists and cableways. Since the

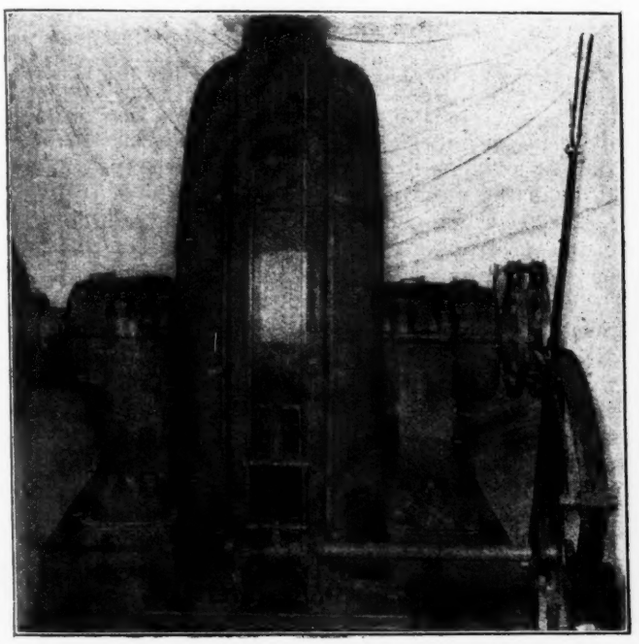


FIG. 1—BAND BRAKE SHOWN ON CENTER OF MOTOR FRAME; OPERATING LEVER ON THE RIGHT

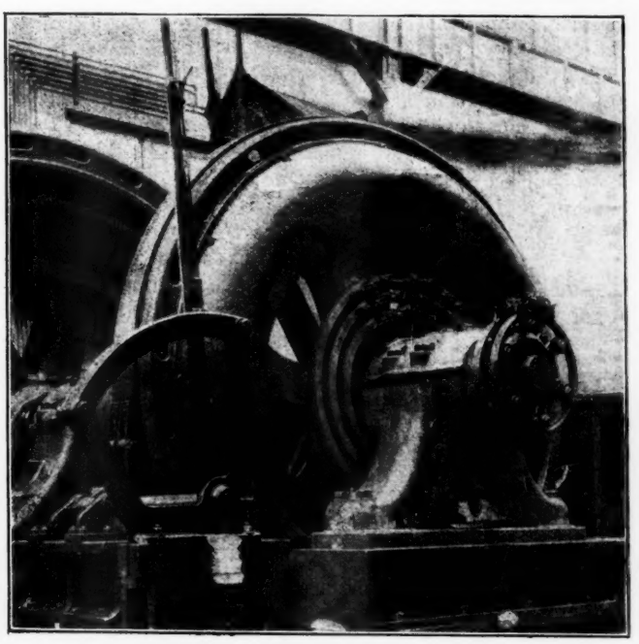


FIG. 2—FIELD SLIP RINGS ON END OF SHAFT; STATOR SLIP RINGS ON FRAME HOUSING

number of starts per day or per year to which the synchronous motor would be subjected, are only a fraction of the number necessary with a mine hoist or cableway, the life of the motor-brake mechanism should be long. This supposition is borne out by the result of tests made on a 450-hp. motor of the new design. The motor was connected to a combination flywheel and friction load of such magnitude that it required 900 hp. for 50 sec. to bring it up to speed, or a total of 45,000-hp.-sec. One-half of this had to be dissipated by the frame and the brake as heat. The test was repeated three times in quick succession without injurious heating of either the motor frame or the band brake. Therefore it can be said that much more work can be done with the new motor than with a motor equipped with a clutch, because of the much greater thermal capacity and radiating capacity of the brake.

As to the field of application of the super-synchronous motor, it is especially applicable to driving heavy line-shafts, fans, centrifugal pumps, or heavy machines that run at low speeds and require high starting torque. An example of the latter is the ball-and-tube mill used in cement manufacture. In the case of centrifugal pumps, where these are started under full head, in the past, when ordinary synchronous motors were used, two courses were possible. One was to "overmotor" the pump, and the other was to use clutches and extra bearings, which expedients were resorted to because of the low pull-in torque of the synchronous motor. With the new motor both these evils are eliminated.

As to its practicability in driving ball-and-tube mills, the test mentioned offers proof as to the abilities of the new motor. Referring to the figures given in the description of the test, it will be seen that the 450-hp. motor used, accelerated a load requiring 45,000-hp.-sec. A 7 x 22-ft. ball-and-tube mill, with a total weight of 165,000 lb., requires approximately 630 hp.-sec. to bring it up to its normal speed of 20 r.p.m. Therefore the motor has shown, in test, that it can exert 72 times the horsepower-seconds that are ordinarily required to start such a mill.

The "Hand Tachograph" Makes Graphic Speed Records

A new instrument for obtaining the speed characteristics of rotating machinery is the "O-Z Hand Tachograph," which consists merely of the conventional

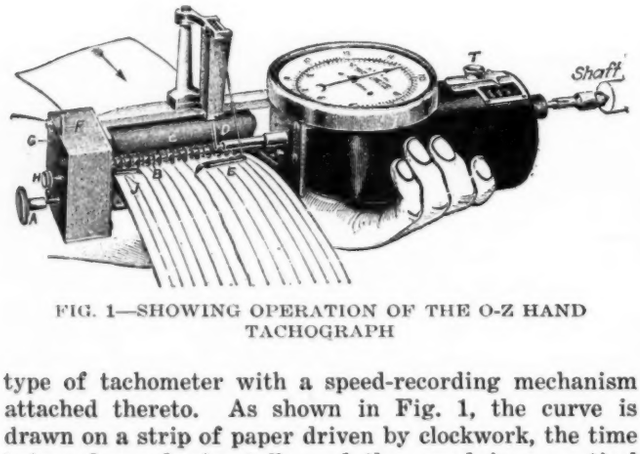


FIG. 1—SHOWING OPERATION OF THE O-Z HAND TACHOGRAPH

type of tachometer with a speed-recording mechanism attached thereto. As shown in Fig. 1, the curve is drawn on a strip of paper driven by clockwork, the time being shown horizontally and the speed in a vertical direction, just as if plotted by hand on rectangular co-ordinates. Any speed from 30 to 24,000 r.p.m. may be recorded.

The clockwork driving the paper feed is controlled by stem *A*, which winds the spring; by lever *F*, which regulates the speed of paper travel, and by lever *G* (in the rear), which stops the movement. Of the two rollers driving the paper strip, the upper one *B* carries

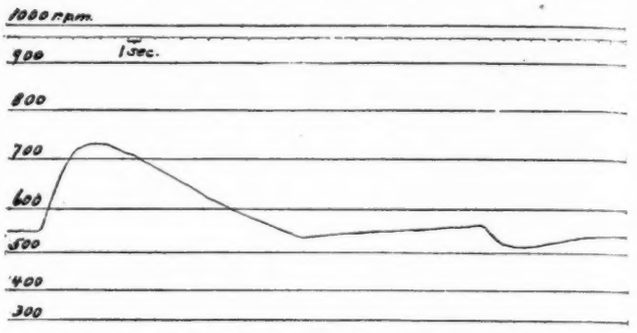


FIG. 2—CURVE OF NOZZLE REGULATION OF A PELTON WHEEL
As drawn by the hand tachograph. The time line is drawn by pen *J* (see Fig. 1).

disks in contact with the ink roller *C*. Thus the longitudinal parallel lines are drawn as the paper feeds through the mechanism.

The recording pen *E* is moved by a lever system and a pin protruding through the housing of the tachometer. A small brush is used to fill the pen with drawing ink, of which a supply is included in the equipment. The pen *J* marks the time in periods of one second or one-fifth second. It is driven by clockwork wound through stem *H*. The disks *B* are adjustable so that the position of pen *E* in relation to the longitudinal speed lines agrees exactly with the graduations of the tachometer dial. The longitudinal lines are labeled by the operator after making the test.

The entire width of the paper strip is available for each of the different speed ranges of the tachograph. If the speed varies by an amount greater than that of a single range of the instrument, the shift to the next higher or lower range is made when the pen reaches the edge of the paper by moving thumb slide *J*, as in the ordinary type of tachometer. Clear registration of small fluctuations is obtained.

A typical chart obtained with the hand tachograph is shown in Fig. 2. The device is put out by O. Zernickow, 15 Park Row, New York City.

Any piece of apparatus that receives electrical power at one frequency and gives off power at another frequency may rightfully be called a frequency changer. Ordinarily, however, the term frequency changer is applied to a motor-generator set consisting of two synchronous machines, or a synchronous machine and an induction motor. The latter set is made up of a synchronous machine and an induction motor and is called an induction set.

An induction motor can usually be operated on a 10 per cent higher or lower frequency than that which the machine was designed for, without seriously affecting its operation. This is also true for the voltage. However, an induction motor will not operate satisfactorily on a 10 per cent increase in voltage above normal, after the frequency has been reduced 10 per cent below normal.

EDITORIALS

F. R. LOW, EDITOR

Operators and Miners Agree

THERE will be no coal strike this spring. Apparently sensing the reaction of an enraged public opinion, the soft-coal operators and miners at their conference in New York last week decided practically to renew the existing agreement affecting the tri-state competitive field of Illinois, Indiana and part of Ohio. This arrangement will hold until the first of April, 1924. With this territory settled, there is every assurance that the other bituminous fields will fall in line. The scale for the anthracite miners has till next September to run and did not enter into the conference.

While the agreement probably will not result in any immediate reduction in the price of coal, it should tend to lessen the evils of a speculative market and will afford opportunity later, after production has caught up with demand, for off-season storage by the consumer. This, in turn, will tend to stabilize conditions pending the investigations of the Federal Fuel Commission and will enable the Commission to proceed with a thorough study of the industry without the distraction of meeting emergency conditions.

Therefore, although the action of the conference should not be taken in any sense as a solution of the coal problem, it will be welcomed as affording a temporary breathing spell pending a permanent solution, which the public insists shall be made.

Co-operation the Key to Firebrick Satisfaction

FEW problems are of greater importance in practical boiler-room operation than those connected with the proper selection and use of refractories. All the way from the mining of the clay to the daily operation of the boilers, there are factors which must be given close and intelligent attention if satisfactory results are to be obtained.

The first of the many difficulties that confront the manufacturer is the necessity for meeting the requirements of his customers in each section of the country from such raw materials as nature has placed within reasonable hauling distance of that particular section. Then come successively the problems of mixing materials in correct proportions for the particular use, of suitable preliminary treatment, of molding with proper allowance for change of shape and volume in burning, of drying for the proper length of time, of so stacking the bricks in the kiln as to insure uniform heating and minimize the bad effects of the pressure on the lower layers, and finally of burning for the proper time at the correct temperature.

Each of these steps calls for the exercise of the greatest care backed by technical knowledge and skill, yet the progressive manufacturer dares not stop when he has furnished the customer with a firebrick suited to his needs. He finds it necessary to keep his organization intimately informed on the troubles the buyer may encounter in using his refractories. Although many of the possible sources of trouble lie in improper application rather than inferior materials, this does not change the fact that the manufacturer's reputation is based largely on the net results obtained by his customers.

The one word that spells mutual satisfaction for the makers and users of refractories is "co-operation." That there is a growing appreciation of this fact was clearly in evidence at last Tuesday's meeting of the Metropolitan Section of the A.S.M.E., in New York City. Starting with a lecture—an excellent one by the way—this developed into a symposium of the most practical sort, where prominent users of boiler-room refractories and representatives of leading manufacturers exchanged views with the utmost frankness. The resulting mutual appreciation of what are, in the last analysis, mutual problems cannot fail to benefit those who attended this meeting.

This might well serve as a suggestion to other sections of the A.S.M.E., N.A.S.E. and other engineering organizations whose members are vitally interested in boiler refractories. Let the men who make firebrick and those who use it get together and talk things over. In that way the co-operation that already exists will be intensified to the great advantage of everybody concerned.

The Cuban Boiler Explosion

WE REGRET that our efforts to obtain for our readers the details of the boiler explosion at the Estrella Mills of the Cuban Sugar Plantations, Inc., mentioned in the December twenty-sixth issue, have, so far, been unsuccessful. To our request for information the company replies as follows:

> Replying to your cable of the second instant, on the above subject, we regret to be obliged to inform you that for a number of reasons it will be impossible, at the present moment, to comply with your request for additional data.
>
> For the present, we limit ourselves to saying that the explosion was far from being as serious in its consequences as reported in the press and, as evidence of this, will state that on the second instant the mill started grinding again, with the equipment and machinery fully restored.

According to general rumor two 96-inch horizontal return-tubular boilers had been subjected to a hydrostatic test and, for this purpose, had been shut off from the line and had their safety valves clamped down. It is possible that they were fired up without the stop valves to the main header being opened and the safeties released. The violence of the explosion lends probability to this assumption of over-pressure.

These two boilers were only nine years old and entirely adequate for the ninety pounds pressure carried, although several of the other boilers in the battery, which did not explode, were considerably older.

If this explanation is correct, it is another instance, of which there are so many, of boilers exploding, not in regular service but when being restored to the line after an interruption. It emphasizes the necessity of particular attention from qualified operatives or supervisors under these conditions.

Boiler Capacity and Efficiency

IT IS natural to suppose that boilers would be rated at or near their maximum efficiency and that, like that of an engine, their efficiency would fall away as the rated capacity was materially exceeded.

And at the time that the ratings of boilers were fixed, this was more or less true. A square foot of heating surface was expected to evaporate about three pounds of water per hour, and as boilers and furnaces were then designed and proportioned, attempts to exceed materially this rating did result in a decrease of efficiency.

But years ago engineers began to realize that it cost less to force boilers over a peak than to carry a battery on bank ready to take the load; and then that it cost less to run fewer boilers continuously above rating than it did to carry a larger installation on a more moderate load.

And finally, it was found that the capacity of the surfaces to absorb heat was nowhere near its limit and that, if the furnace was so designed that the necessarily larger amount of coal could be efficiently burned, the capacity could be doubled or trebled with little effect upon the efficiency.

In a recent editorial *Engineering* deplores the failure of boiler development to keep up with that of the engine and turbine. "At one time," it says, "the recognized economic limit of water-tube boilers was about three and one-half pounds of steam per square foot of heating surface, but in the test at the River Rouge plant the output was nearly three times this figure."

And then it manifests the persistence of the old idea by saying: "Generally speaking, high boiler outputs imply a low efficiency, and it would not be surprising if in the foregoing case the efficiency corresponding to maximum output was under 60 per cent."

There has been no formal test of the large Ladd boilers at the River Rouge plant of the Ford Motor Company, but daily records are kept of the fuel burned and water evaporated. These indicate that these 26,470-square foot boilers, when delivering an average of 225 per cent of rating or 180,000 lb. of steam per hour for periods of six months, show operating efficiencies better than 82 per cent; that, when delivering 276,000 pounds per hour at a rating of 350 per cent, the efficiency is over 80 per cent, and that, when delivering 328,000 pounds per hour, the exit temperature of the flue gases is under 700 degrees F.

The classic tests by Dr. Jacobus on the 23,650-square foot boilers at the Delray Station of the Detroit Edison show a decrease of efficiency from 82 to 76 per cent in an increase of from 75 to 200 per cent of rating.

Tests on a similar boiler since installed at the Connors Creek plant of the same company, reported by Paul W. Thompson at the recent meeting of the American Society of Mechanical Engineers, show a falling off from about 82 per cent at rating to about 78 to 210 per cent, but these boilers were not designed for sustained efficiencies at high ratings as were the boilers at River Rouge.

In the tests reported by Mr. Thompson, the loss from incomplete combustion and combustible in the refuse varied from two to five per cent, whereas the boilers at River Rouge are fired with powdered coal, the larger furnace capacity and higher temperatures leading to more complete combustion with resultant increased efficiency.

White-Foster marine boilers built by the Babcock & Wilcox Company have run at 675 per cent of rating without dropping their efficiency below 75 per cent.

The efficiency line for large boilers is more nearly straight from 100 to 300 per cent rating than are corresponding curves for turbine units.

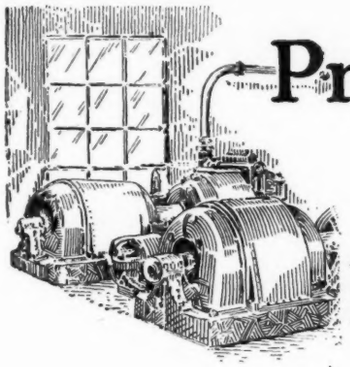
Alexander Dow, president of the Detroit Edison Company, the pioneer in the use of large boilers in this country, credits a British engineer, W. H. Patchell, who mounted two boilers of 10,850 square feet each over a single furnace at the Bow Station, London, with the first idea of the possibilities of large boilers. Another British engineer in a contribution to the *Electrical World* says that the River Rouge installation "probably represents the extreme limit of development in the size of steam-power units under existing conditions and that the pendulum will now swing back in the direction of smaller and more easily controlled boilers and furnaces for steam generation." As a matter of fact, the Detroit Edison Company has just installed 29,880-foot units at Marysville, boilers are now under production containing between 30,000 and 40,000 square feet and boilers containing 90,000 square feet have been laid out, using standard materials, on which the unit stresses will be no greater than those on the material of large boilers now in operation.

Development of Small Water Powers

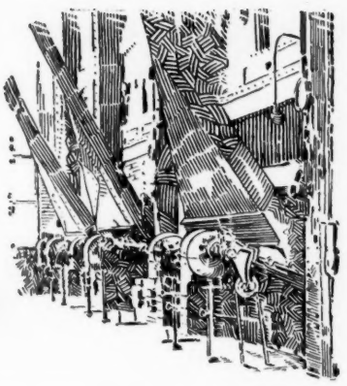
WHERE large water powers are within reasonable transmission distance of a load, their economic development is fairly well assured by present methods. There are localities near cheap fuel supplies where this may not be true, but these are exceptions and not the rule. With small water powers economy of development is influenced by factors that make the undertaking of a more doubtful nature. In a plant of twenty-thousand kilowatts output but one operator will be required per shift, which makes the cost of attendants a rather inconsequential item compared with the return from the sale of power. But if a five-hundred horsepower plant is operated with manual control, it will have to pay practically the same charges for attendants as the larger plant, and if operated at the same load factor, will deliver but one-fortieth the power. In the small plant the operating charges may preclude the economical development of the power site with a manually controlled station.

In developing small water powers both the full-automatic and the remotely controlled types of plant are becoming important factors. The best type to use in any particular development will depend upon local conditions. If the only question is that of generating power and supplying it into a transmission system and the plant is a considerable distance from other stations, then the full-automatic equipment is generally the best solution. On the other hand, if the water power is within a reasonable distance of an attendant-type station and it is desirable to have control of the plant, a remote-control equipment is probably best. In either case the cost of attendance is quite small compared with that for the manual-type plant.

The leading article in this issue shows how small water powers may be developed under a given set of conditions. From a financial point of view the cost of operating an attendant type of plant would have prevented making this development, but it was made economically possible by remote control from another plant of the system.



Practical Ideas *from* Practical Men



Best Method of Putting Generators Into Service

One of your departments of *Power* is devoted to the discussion of power-plant troubles, operating methods, etc., therefore I am taking the liberty of asking for an opinion on the following method of recovering load on parallel operated turbo-generators, such load having been dropped owing to the loss of field excitation on both generators.

In this case two turbo-generators of 6,000-kw. and 4,000-kw. capacity respectively were operating in parallel with exciters also in parallel; field excitation was entirely lost on both generators and consequently the load. However, the machines were still up to speed and the generators were tied together through the busbars. Load was recovered by building up the field on both machines at the same time while still in parallel, from one exciter. When voltage was brought back to normal, there was about 1,000-kw. load on the two machines. The fields of the two alternators were excited from a common bus so that both could be excited at the same time, by closing the exciter switch to the busbars.

I would like to hear from some of *Power's* readers if the foregoing method would be considered good operating practice. If not, why? Also what would be considered the best method of getting the machine back in service and carrying load? F. G. INGALLS.

Fraser, Iowa.

Experience with Water Leaking Into Diesel Engine Cylinder

An experience that I had with water leaking into the cylinder of a Diesel engine and the effect it had on the engine's operation may be of interest to *Power* readers. The engine, a single-cylinder machine, 17-in. bore and 27-in. stroke, had been operating nicely, when suddenly it stopped. Examination revealed a small crack in the cylinder head which allowed water to enter the cylinder. The engine was needed badly and had to be kept running if possible. No extra head was on hand, and the engine could not be spared long enough to attempt to make repairs. The crack was small and the water barely seeped into the cylinder when the machine was standing idle with the circulating water flowing. We first attempted to start the engine again with the cooling water flowing, but with no success. Next we drained the water from the jacket and this time it started all right. Immediately after it began to run under its own power the cooling water was turned on and it at once stopped firing. On the third attempt the cooling water was left cut off until the engine had come up to speed and the cylinder head was fairly warm, whereupon it continued to fire after the water was turned on.

This engine was operated in this condition for several weeks, but it was necessary to keep the cooling water cut down so that it left the jacket at a temperature in excess of 140 deg. F., otherwise the engine would miss, and invariably if it missed firing one time, it stopped entirely. No difficulty was encountered in starting with the cylinder jacket dry, so it was plain that the crack did not lower the compression to any great extent, and it was reasonable to suppose that no great amount of water could enter the cylinder while the engine was in operation. J. H. BENDER.

Crosbyton, Tex.

Half-Size Governor Valves for Small Turbines

Small steam turbines in sizes ranging from 1 kw. to 100 kw. have been installed in large numbers in the last few years, particularly in isolated plants and marine service. In a number of installations observed by the writer, a considerable amount of trouble was experienced with the governors. The valve seats were found badly wiredrawn, and during very light load operations the thrust mechanism had considerable stress thrown on it due to overspeeding of the turbines and consequent governor pull, so that rapid deterioration was the result.

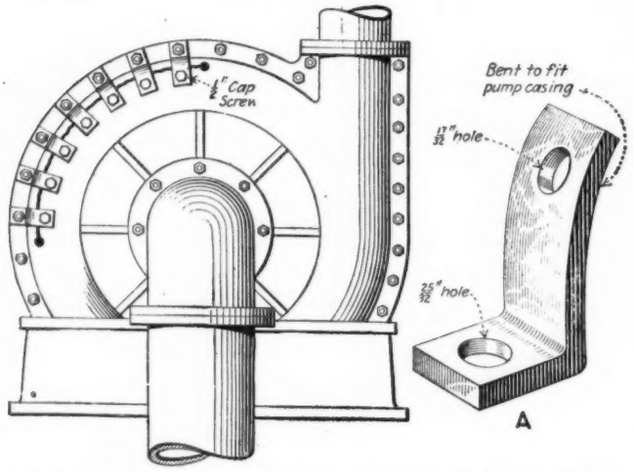
The cause could be traced to the fact that those turbines giving trouble operated normally at a point about half load or below, consequently the governor valve never opened wide enough to prevent a wiredrawing effect on the valve seat, and when there was no load on the machine, enough steam could pass the closed governor valve to overspeed seriously the unit.

This condition may be obviated by the use of a half-size governor valve, which can be secured from nearly every turbine maker, and then the governor will open it up sufficiently to give a clear passage to the steam during normal operation. While many turbine instruction books carry this advice, it is apparently not heeded by the majority of men in charge of small outlying plants, and often regulation is accomplished by cracking the turbine steam-line valve or else a continued expense for governor parts and valves is necessary. A check on the load carried by the small turbine may show why turbine maintenance is so much higher than that of small engines in the plant. A half-size governor you may find will reverse the figures.

Kansas City, Mo. J. ELMER HOUSLEY.

How a Fractured Centrifugal Pump Casing Was Repaired

A second-hand centrifugal pump was installed for raising water from a creek and delivering it through a set of filters in an ice-making plant. After the pump had been in service a few days, a crack appeared in the casing about as shown in the cut. Apparently, the crack was due to a flaw that had existed in the casting from the time it was poured in the mold. The weak



IRON CEMENT WAS WORKED INTO THE CRACK, THEN EACH STRAP WAS HEATED AND BOLTED IN PLACE

place was strong enough to hold under the light service for which the pump previously had been used, but the stress due to the greater head in its present service was too much for it to withstand.

The damage was repaired by first drilling and tapping a hole at each end of the crack for the insertion of ½-in. pipe-threaded copper plugs. This was to prevent further extension of the fracture. A number of angle straps, of the form shown at *A* and about 6 in. long over-all, were then forged from a bar of ½x2-in. steel. A 17/32-in. hole was drilled in the long end of each strap and a 25/32-in. hole in the short end. Each strap was then expanded by heating it to a dull red, and bolted to the flange of the casing, and the location of a hole corresponding to the 17/32-in. hole in the long end was scribed on the casing. The series of holes thus laid off were drilled and tapped for ½-in. capscrews. An iron cement was then worked into the crack, and each strap was reheated and fastened in place. The shrinkage of the straps, due to cooling, pulled the edges of the fracture tightly together.

A. J. DIXON.

St. Louis, Mo.

Shall the Engineers Be Tethered?

There are "engineers" who are occupying their present status in life because of a miscarriage of justice and a shaping of circumstances over which they have had no control. But on the whole I speak the truth when I say that men are engineers because they are men of brains, and being men of brains, they are never satisfied.

The great trouble with most engineers is not that too much is expected of them, but that not enough is expected. A good man is continually on the alert for the solution of new problems, and it matters nct to his thinking mind whether it be an engineering problem, a mechanical problem or a problem in ethics—he is always interested in an unsolved problem. I know an engineer whose plant is a model of quietness. You would be unable, when entering the boiler room blindfolded, to tell that the boilers were under steam; in the engine room the equipment seems to move by the touch of some fairy wand—there is no escaping steam, no dripping oil, no pounding bearings; and yet this man points with pride to the fact that he has not, in three years' time, "worked" his men either nights or Sundays. He takes an active interest in all municipal problems, is a member of the leading civic and social clubs, is a regular attendant at divine worship and holds a license to preach, which prerogative he exercises at different times.

To the best of my knowledge, from observation and intimate acquaintance, he is in no way overburdened and stands at all times ready to take such added responsibilities as his employer may delegate to him. His one complaint, if he has one, would be that he is tethered—that his pasture is not large enough for the full development of his pent-up energies.

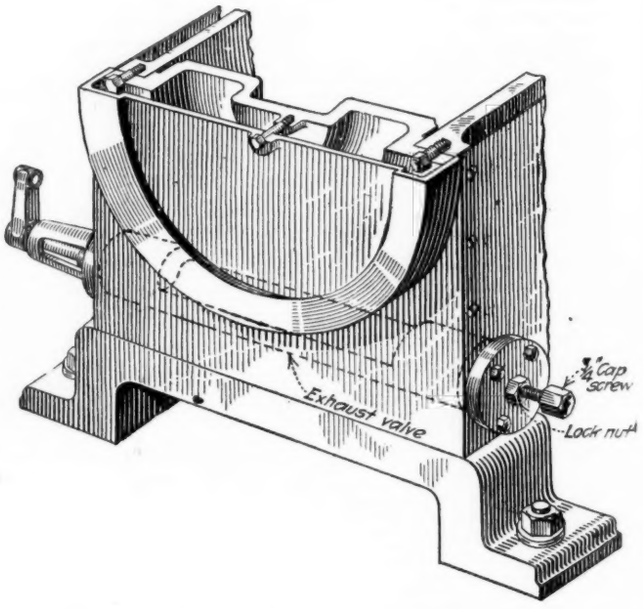
I believe he has the right spirit, and I am passing it along, hoping his attitude toward engineering may prove of inspiration to my fellow engineers, as it has to me.

LINDEN C. TROW.

Rochester, Minn.

Taking up End-Lash on Exhaust Valves

In a plant that depended on the tides for condensing water, a large Corliss engine had frequently to be changed from condensing to non-condensing operation. While running non-condensing, there was considerable



END-LASH IS TAKEN UP BY ADJUSTING CAPSCREW

annoyance from the noise caused by the end-lash of the low-pressure exhaust valves.

The back valve bonnets were drilled and tapped in the center, for ¾-in. capscrews (as shown). While the engine was hot, the capscrews were set up against the ends of the valves, then backed off about one turn and the locknut tightened. The valves now operate quietly, and not oftener than once in six months is it necessary to tighten up a little on the capscrews to take up any wear that may occur.

M. M. BROWN.

Camden, Me.

Comments from Readers

Emergency Governor Trips When Overload Opens Main Switch

I was interested in the inquiry by R. G. L. in the Nov. 21, 1922 issue as to the cause of the emergency governor's tripping out the unit when overload opens main switch.

The fact that the emergency trip operates and shuts the machine down is good evidence that it is functioning properly and has good control over the turbine. Undoubtedly, the machine increases in speed considerably, owing to a sluggish action of the main governor or valve gear.

Where turbines of 500 to 8,000 kw. operate condensing and have a number of steam-control valves in the steam chest, with one valve wide open, the speed of the unit will increase at the rate of 1 per cent a second, and if a number of the admission valves are open when the load is suddenly thrown off the generator, it sometimes happens that before the governor and hydraulic gear will function and close the valves, the emergency trip will have operated and shut the steam off the unit. In plants where interruptions are frequent, it is advisable, in my opinion, to have a no-voltage relay installed at the trip hook of the throttle valve. This will be an additional safeguard, as it will cause the valve to close each time the generator breaker opens under load. WILLIAM TOMPKINS.

Philadelphia, Pa.

How Is the Leakage Past the Piston Best Determined?

In the Dec. 12, 1922, issue of *Power*, C. C. Moore inquires as to the best method of determining the piston leakage of small steam pumps; he also states that he has placed the pistons in the middle of the stroke and put steam on to see if it would blow past the piston rings.

This is a good way of testing for leakage, but in making a test of this kind the piston should be moved to various parts of the cylinder in order to ascertain which part showed most leakage. In my experience with small pumps I have found the middle of the cylinder in good condition, while both ends close to where the steam entered were badly worn. When new rings are used in worn cylinders, it usually requires a few weeks' operation of the pump to bed the rings to the cylinder sufficiently to stop the leakage. If the cylinder is badly worn, the only practical repair is to rebore it and fit new rings or install a new liner.

New York City. P. J. MOLLOY.

I suggest that Mr. Moore check up the piston clearance by using a caliper on the piston and cylinder. It is possible that they have worn to the extent that it will be difficult to get results even from new rings. It is hard to judge the amount of leakage in this manner, as the gap in the rings causes some leakage in any case and cannot be entirely overcome. This should, however, be only a small amount if care is taken in fitting the rings and the cylinder is in good condition.

McComb, Ohio. F. R. BURGOON.

One method of testing that will give a fair approximation of the amount of steam leaking past the piston is to connect the exhaust of the pump into a barrel half full of water. This will serve as a condenser for the steam. Then set the valves of the pump so that steam will be admitted only to one end of cylinder, while the other end is open to the exhaust. After making sure that the steam valve of the pump is tight so that no steam will be admitted to the exhaust except by passing the piston, block the piston in position, turn the steam on full and let it blow through for a few minutes. By carefully measuring or weighing the water before and after testing and noting the time, the amount of leakage can be determined. E. A. CURTIS.

Cleveland, Ohio.

Another Way to Check Multiplication

In looking through the Jan. 9 issue of *Power*, I find the page, "Easy Lessons in Engineering," and note the proving of different operations of arithmetic. I think I can give an additional proof for the correction of multiplication. Take for example the problem given in the article:

$$\begin{array}{rrr} 792 & 18 & 9 \\ \times 265 & 13 & 4 \\ \hline 3960 & & 36 \\ 4752 & & \\ 1584 & & \end{array}$$

$$= 209{,}880 \quad 27 \quad 9$$

Add the figures of the multiplicand until only one figure remains, as $7 + 9 + 2 = 18$, $1 + 8 = 9$. Add the multiplier in the same way, as $2 + 6 + 5 = 13$, $1 + 3 = 4$. Now multiply these, as $9 \times 4 = 36$; then add, as $3 + 6 = 9$. The sum of the figures (reduced to one figure) in both products will be the same: as $2 + 9 + 8 + 8 = 27$, $2 + 7 = 9$.

This is a sure check on the correctness of the operation, and an easy way to prove a long multiplication.

If, in proving any multiplication, the sum of figures in either the multiplier or multiplicand totals 9, the sum of figures in the product will also be 9, so it is not necessary to multiply the sum of figures in the multiplicand by the sum of figures in the multiplier, for if you get a sum of 9 in either of these it is impossible to eliminate it from the product.

Verona, Pa. HARRY W. STEVENSON.

[The foregoing, as one of the well-known methods of checking, was considered in preparing the article "How to Avoid Mistakes in Arithmetic." It was not included on account of lack of space. Although this check is

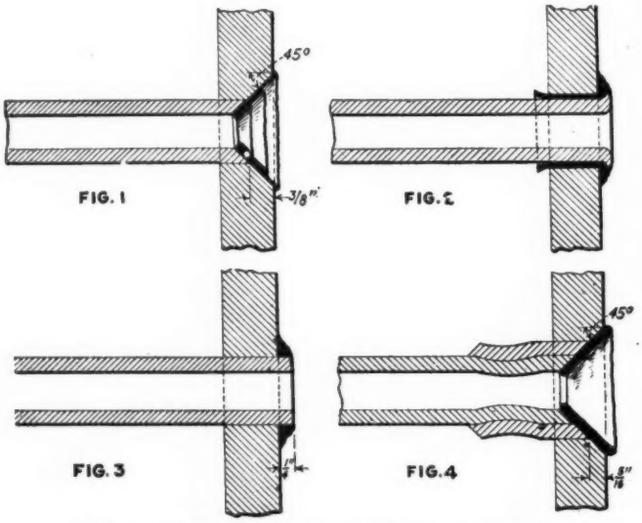
more convenient than that of repeating the multiplication in the reverse order, it is *not* an absolutely sure check. For example, any of the following answers would appear to check by this method: 20,988; 2,098,800; 208,980; 209,808, etc. This check merely shows that the answer is probably right. The method shown in the article on the other hand, cannot possibly check a wrong answer unless another mistake in arithmetic is made in refiguring.—Editor.]

Welding Tubes into the Tube Sheets of Boilers

The questions asked by L. Johnson in the Oct. 24, 1922, issue and the comment made by R. G. Spooner in the Nov. 21 issue and by H. R. Wass in the Dec. 5 issue relative to my article on "Welding Tubes into the Tube Sheets of Boilers," in the Oct. 10, 1922, issue were interesting and instructive.

Each application of electric-arc welding brings with it its difficulties, and each has to be overcome with careful research and practice on the part of those interested in its successful completion. For instance, the steel in tires on locomotive drivers or in electric car wheels differs in chemical contents from the steel in boiler plate owing to different physical requirements, and the deposited metal must of necessity be such as to adequately meet these physical requirements when the built-up part, or the weld, is completed. The subject of welding is a broad and interesting one and has practically no limit.

L. Johnson has evidently chosen his questions with the intention of systematically getting at the essentials of the welding of tubes into the tube sheets of boilers,



FIGS. 1 TO 4—SHOWING DIFFERENT TYPES OF WELD ON WHICH TESTS WERE MADE

with the result that they have brought out in the replies some interesting facts relative to tube welding.

A series of tests recently made by the writer and others will give those interested in this work an idea of the strength of the various methods of tube welding. The results of the tests are given herewith. The method of procedure was as follows: A plate ½ in. thick and 6 in. square with hole cut out for the 2¼-in. tube, was used, and a tube about 18 in. long was welded in, in accordance with the various practices. The end of the tube was flattened so as to enable a tensile test to be made without injuring the weld and to obtain conditions similar to actual service.

Test No. 1—Tubes were rolled in sheet without copper ferrule, and countersunk ⅜ in. deep at an angle of 45 deg. The weld was made with one bead covering the whole of the bevel, as shown in Fig. 1. Tube No. 1 gave 41,225 lb. tensile strength; No. 2, 41,625 lb.; No. 3, 39,656 lb. In each case the tube broke about 6 in. from the weld.

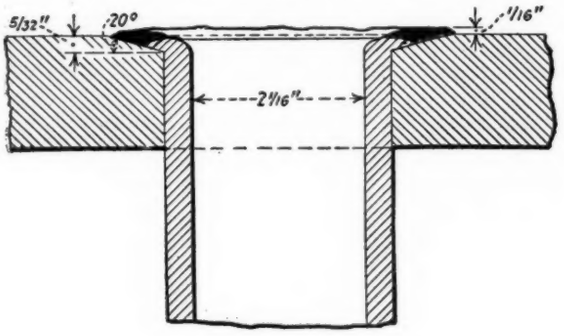


FIG. 5—SUCCESSFUL WELDING METHOD, FULL TUBE AREA AVAILABLE

Test No. 2—Tubes were applied with a copper ferrule, prossered, rolled and beaded. The tube was then welded to the sheet along the edge of the bead, as shown in Fig. 2. Tube No. 1 gave 42,160 lb. tensile strength; No. 2, 34,560 lb.; No. 3, 34,480 lb. The tubes parted half through the bead and half through the weld.

Test No. 3—Tubes were rolled into the sheet without copper ferrule, the tube projecting through the sheet ¼ in., and fillet was welded around the outside of the tube, as shown in Fig. 3. Tube No. 1 gave 36,400 lb. tensile strength; No. 2, 44,750 lb.; No. 3, 38,370 lb. No. 2 tube pulled apart, the other two separated partly through the tube and partly through the weld.

Test No. 4—The tube was swaged and a ferrule of similar material was welded on the tube, which was then rolled into the tube sheet without a copper ferrule, sheet countersunk ⅝ in. deep at an angle of 45 deg. Then the end of the tube was ground off bright finish before welding, as shown in Fig. 4. Tube No. 1 gave 23,550 lb. tensile strength; No. 2, 25,910 lb.; No. 3, 36,300 lb. In 1 and 2 the tubes pulled from the weld and in 3 the tube partly pulled away and partly broke through the welded metal.

Test No. 5—The tube sheet was countersunk 5/32 in. deep at an angle of 20 deg. The tube was rolled into the sheet without a copper ferrule and with the end of the tube flush with the face of the sheet. The tube was flanged over after rolling and the rest of the countersink filled with welded metal, shown in Fig. 5. Tube No. 1 gave 38,650 lb. tensile strength; No. 2, 38,700 lb.; No. 3, 39,400. The tube broke 6 in. from the weld in each case.

It will be noted that the tubes in tests Nos. 1 and 5 gave a uniform and as high tensile strength as in test No. 2; that the rupture occurred in the tubes of Nos. 1 and 5, whereas the welds were the weak parts in test Nos. 2, 3 and 4. The tensile strengths were low, especially in test No. 4.

R. G. Spooner in his reply brings out a point of interest—that of having water in the boiler while welding. This practice, tending to reduce the heat in the tube sheet, has a beneficial effect on the plate at

the weld, in that it reduces the crystalline structure that would otherwise become coarse and weaker. It is the writer's opinion that the coarse structure often noted in microscopic examination of welds is due to impurities in the plate as well as to the heat of the arc. Owing to the intense local heat of the arc a small portion of the plate is made molten and united with the melted electrode, forming a small bead that becomes cooled more or less rapidly. The heat goes deeper, and about $\frac{1}{8}$ in. back from the weld the plate is heated high enough so that upon cooling it is of a different structure than the plate before welding. This is coarse or fine, depending on the cooling. With good plate and skillful handling of the welding operation, the plate is simply annealed and in some cases a very fine grain is the result. None of the chemical contents is removed, and there is no reason why the welding process may not be used indefinitely on a single tube sheet, and it is my belief that less rolling is required. This would in turn give the tubes a longer life and probably avoid undue rolling and enlarging of the hole in the tube sheet and consequent weakening of the tube by rolling it to fit the hole.

The writer advocates the use of a flux-coated electrode of medium carbon steel and containing about 1 per cent manganese. This gives a weld that is clean, a metal free from blow-holes, oxides, etc. This means additional security against leaks. Wilson Plastic Arc Colortip, Blue, No. 9 is the best so far as the writer's experience goes and the Quasi Arc, a slag-coated electrode, comes next.

FRED H. WILLIAMS,
Assistant Electrical Engineer,
Moncton, N. B. Canadian National Railways.

I read the article and the discussion on welding tubes in the tube sheets of boilers with a great deal of interest. In the last few years I have had a number of experiences with repairs made on boilers with the electric arc that perhaps will be of interest to *Power* readers.

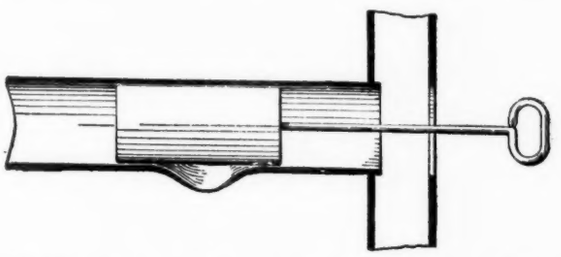
While in charge of a plant containing eight 90-in. x 21-ft. horizontal return-tubular boilers, a blister developed in the fire sheet of one boiler, caused by slag inclusion in the plate. This spot, as it developed, measured $2\frac{5}{8}$x$3\frac{7}{8}$ in. This piece was cut out, leaving a hole in the sheet $3\frac{3}{4}$x$5\frac{1}{8}$ in. A piece of plate of the same thickness was then fitted into this hole with the edges of boiler plate and plug both beveled. It was then welded with the electric arc on each side. This repair was made about six years ago. The boiler operates on 140 lb. pressure, and no sign of weakness or leakage has developed.

I also experienced considerable trouble with leaking of tubes in the crown sheets of large vertical fire-tube boilers, due to deposits of calcium sulphate on the crown sheets. The tubes had been rolled so often that the boilers would shortly have to be retubed or an effort made to make the tubes tight. The trouble was successfully overcome by electric welding the tubes to the sheet.

This method has also been successfully used in stopping leaks on the joints of horizontal water-tube boilers at the point where the butt strap joins the front and rear heads, and in the stopping of leaks on flanged pipe joints where the flanges were shrunk and peened onto the pipe the welding is done on the outside of the joint.

The old method of cutting out a portion of a boiler sheet that has become badly corroded and replacing it with a riveted patch is now being replaced by the more practical method of building up the corroded portion to its original thickness with the electric-arc method and then trimming off any excess of new metal with an air hammer. By this process there is a considerable reduction in time and cost usually required for making repairs of this kind.

While serving during the war as chief engineer on one of the wartime-built ships, we arrived at a foreign port with fourteen or fifteen badly blistered tubes in our water-tube boilers, ten of which were leaking. After a consultation with the boilermaker it was decided to repair the tubes in place. A plug nearly the inside diameter of the tube was placed in the tubes as shown in the cut to serve as an anvil. The blister was then heated with a gas torch and hammered back to about its original shape. Where leaks had developed in the



PLUG SERVES AS ANVIL, WHILE HAMMERING BLISTER BACK TO ORIGINAL SHAPE

blister, the outside was covered with metal deposited by the electric arc. We left the port with all boilers in use and operating at 200 lb. pressure, spent three months cruising to various ports and traveled in all about 15,000 miles before arriving at a home port, during which time no further trouble was experienced.

J. F. NAGLE.

Hackensack Water Company's High-Head Pumping Engines

In the description of the high-head pumping engines installed by the Hackensack Water Co., given in the Dec. 26, 1922 issue, there appeared a statement that, "translated to power-plant standards, the duty is equivalent to production of a kilowatt-hour at the switchboard on 16,600 B.t.u."

From a review of the test data submitted, it appears that this means 16,600 B.t.u. delivered to the engine throttle. Now in central-station power-plant practice, when we talk of B.t.u. per kilowatt-hour, we generally refer to the B.t.u. in the coal delivered to the boiler. The figure of 16,600 B.t.u. naturally attracted my attention because it is somewhat better than any of the larger and most efficient steam-turbine plants are actually able to obtain in all-day work under operating conditions, and corresponds closely with their theoretical full-load performance based on B.t.u. in the coal. Consequently, I feel that the statement of economy as given in the article is somewhat misleading, since, while these pumping engines show excellent performance, yet in order to translate that performance to power-plant standards, the B.t.u., in the coal per kilowatt-hour should have been given.

H. R. SUMMERHAYES,
Engineer Lighting Department,
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QUESTIONS AND ANSWERS

Conducted by Franklin VanWinkle

Saving of Natural Gas from Covering Hot-Water Tank

What number of cubic feet of natural gas should be saved per hour from covering a steel hot-water tank with 1½-in. thick asbestos block? The area of tank surface to be covered is 66 sq.ft. The tank is kept filled with water at the temperature of 210 deg. F. and is supplied at the rate of 250 gal. of water per hour through a copper-coil gas-heated water heater which receives the water at the temperature of 60 deg. F.

L. S. S.

Assuming that the atmosphere surrounding the tank is at the temperature of 70 deg. F., the temperature difference is 210 — 70 = 140 deg. F. With this difference the loss of heat by radiation to the surrounding air could be about 2.1 B.t.u. per degree difference of temperature per square foot of bare surface, per hour; that is, without covering, the loss would be

$$140 \times 2.1 \times 66 = 19{,}404 \text{ B.t.u. per hour}$$

Average natural gas has a heat value of about 1,000 B.t.u. per cubic foot, and allowing 50 per cent efficiency for the heater, the radiation of heat from the bare water tank would require combustion of about

$$19{,}404 \div (1{,}000 \times 0.5) = 38.8 \text{ cu.ft. of gas per hour}$$

The efficiency of 1½-in. asbestos block covering would be about 75 per cent, and the actual saving would be approximately 75 per cent of 38.8 = 29.1 cu.ft. of natural gas per hour, or about 0.44 cu.ft. of gas per hour per square foot of the covering.

Increasing the Number of Turns in an Induction-Motor Winding

In a 440-volt 60-cycle three-phase induction motor the original coils were made of 6 turns of copper strap and the winding was connected in series star. New coils for this motor were purchased several years ago and were made of 10 turns of small strap and two in parallel. This was brought to the attention of the manufacturer who contended that the coils were correct. These new coils were of less carrying capacity and more resistance, and I told the owner of the motor that it would not develop the power as with the old coils. Since we did not have any other coils and needed the motor, the coils were put in and connected up as in the original winding. With the new winding the motor stalls on heavy loads and does not blow a 60-ampere fuse; with the old coils and the same load the motor would not stall, but would blow a 60-ampere fuse, which indicates too much resistance in the new coils. What change is necessary to make this winding suitable for the original line conditions? What would be the result if a motor wound for 440-volt 60-cycle were connected up on a 440-volt 25-cycle line? E. A. B.

Changing the number of turns in the coils from 6 to 10 and leaving the winding grouped as originally, makes it good for operation on $440 \times 10 \div 6 = 733$ volts. In other words, as the winding is now connected you have a 733-volt motor operating on 440 volts. Since the torque varies as the square of the voltage impressed on the motor, with the star-connected winding the motor will develop $100 \times 440^2 \div 733^2 = 36$ per cent of the torque it would on full voltage, which accounts for the machine's stalling.

If this winding were connected series-delta instead of series-star, it would then be good for operation on $733 \div 1.732 = 423$ volts. This is less than 4 per cent below line volts, therefore, the motor will operate satisfactorily on 440 volts.

A motor wound for 440 volts 60 cycles would be good for only $440 \times 25 \div 60 = 183$ volts on a 25-cycle circuit, and the motor will operate at a speed equal to $100 \times 25 \div 60 = 42$ per cent of that on 60 cycles. The horsepower will also be reduced to 42 per cent of the original rating.

Determining Air Compressor Capacity

How can determination be made of the quantity of "free air" per minute handled by an air compressor?

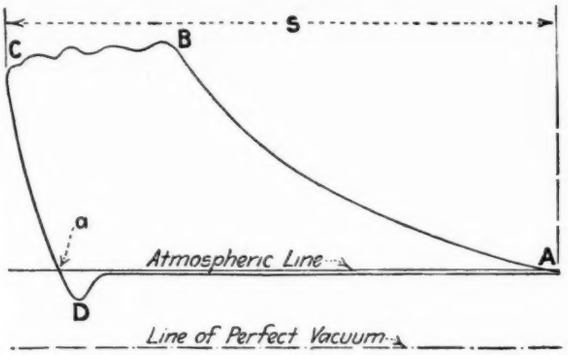
R. L. M.

Knowing the piston displacement, the quantity of free air received and discharged per stroke can be closely approximated from an indicator diagram. The illustration shows a typical indicator diagram from an air compressor where *S*, the full length of the diagram, represents the volume displaced by a full stroke of the piston. The lines representing the actual diagram are *AB*, compression line; *BC*, delivery line; *CD*, expansion line; and *DA*, admission line.

Starting with the piston at *A* and the cylinder full of air, the pressure of the confined air rises as its volume becomes reduced by movement of the piston, until a pressure *B* is obtained somewhat higher than necessary for opening the discharge valve against the receiver pressure. Continuing its motion from *B* to the end of the stroke, the piston forces the compressed air into the receiver. The wavy appearance of the line from *B* to *C* is due to fluttering of the discharge valve and inertia of moving parts of the indicator.

Upon completion of the stroke at *C* the discharge valve closes, leaving the clearance space at the end of the cylinder filled with compressed air. Then as the piston returns toward *A*, the air in the clearance space expands until a pressure a little below that of the atmosphere is reached, as at *D*, when the inlet valve opens and "free air" flows into the cylinder until the piston moving toward *A* arrives at the end of the intake stroke.

It is to be noted that the compressed air left in the clearance space when the piston arrived at *C* becomes expanded down to atmospheric pressure at the point *a* where the expansion line *CD* crosses the line of atmospheric pressure; also that when the intake line from *D* toward *A* is below the atmospheric line, as shown, then the cylinder is not filled with air at atmospheric pressure until the piston returns on the compression stroke a sufficient distance for the compression line to rise to intersection with the atmospheric line near the beginning of the stroke at *A*. Hence, neglecting the difference of volume that may be due to difference of temperature between the "free air" and air at atmospheric pressure contained by the cylinder, the net volume of intake air per stroke is represented by the piston displacement measured along the atmospheric line from *a* to the point where the atmospheric line is intersected by the compression line *AB;* and, knowing the piston displacement per stroke, the volume compressed per stroke from atmospheric pressure would be the gross volume of piston displacement multiplied by the length from *a* to the intersection at *A* and divided by *S*.



TYPICAL AIR COMPRESSOR DIAGRAM

Accounting for Superheating at Reduced Pressure

For supplying our paper machine, saturated steam at the initial pressure of 130 lb. gage is reduced to 20 lb. gage and thence passes through a regulating valve, with a final pressure of 2 lb. gage. Six feet beyond the second regulating valve the temperature is 280 deg. F., showing about 60 deg. of superheat. How is the superheating accounted for? S. W. C.

A pound weight of dry saturated steam at the pressure of 130 lb. gage, as it leaves a boiler, contains, 1,192.8 B.t.u., and when that same quantity of steam passes through a pipe, throttle valve or one or more reducing or regulating valves, the pressure may be lowered, but the same weight of steam contains the same 1,192.8 B.t.u. except for the heat that may be lost by radiation.

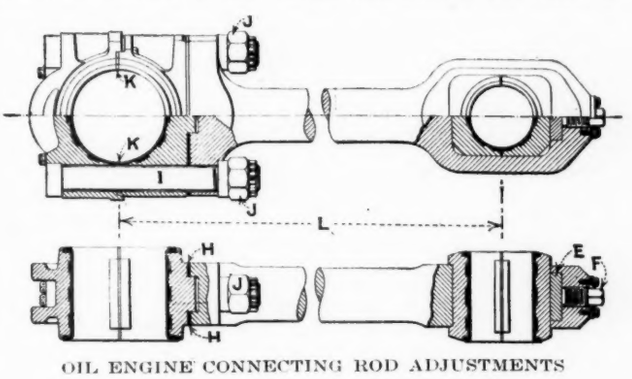
A pound weight of dry saturated steam at 2 lb. gage pressure contains 1,153.1 B.t.u. If no heat were lost in passing from the condition of dry saturated steam at 130 lb. gage pressure to 2 lb. gage pressure, each pound weight of steam in the final condition would contain 1,192.8 — 1,153.1 = 39.7 B.t.u. more than necessary to be in the condition of dry saturated steam at 2 lb. gage pressure, with the result that the temperature would be about 84 deg. F. higher than the temperature of saturated steam at 2 lb. gage pressure. The number of degrees higher is called the degrees of superheating. Without loss of heat by radiation the condition of the steam would be the same as if dry saturated steam were generated at 2 lb. gage pressure, with each pound weight of the steam containing 1,153.1 B.t.u. above 32 deg. F., and subsequently each pound received 39.7 B.t.u. additional while permitted to expand without undergoing a change of pressure.

By reference to tables of properties of superheated steam it may be seen that if the steam after passing through the reducing valves was at the pressure of 2 lb. gage or 17 lb. per sq.in. absolute and at the temperature of 280 deg. F., then each pound weight of the steam in the final condition must have contained about 1,181.4 B.t.u., whereas a pound of dry saturated steam at the initial pressure of 130 lb. gage, or 145 lb. per sq.in. absolute, contains 1,192.8 B.t.u. The difference, or 1,192.8 — 1,181.4 = 11.4 B.t.u. per lb., is due to loss of heat by radiation in transmission of the steam from the boiler, or part of the shortage may be due to the fact that the initial steam at 130 lb. gage pressure was not in a dry saturated condition.

Adjustment of Oil-Engine Connecting Rod

The connecting-rod bearings of our oil engine have no wedge adjustment to take up the wear. How is this adjustment made, and what will be the effect of taking up the wear on the rod length? R. C. L.

Most Diesel engines have marine-type rod bearings as shown in the illustration. To take up the wear in the crank bearing, slack off the nuts *J* on the bolts *I*, and allow the outer half of the bearing to leave the pin enough to insert two lead wires across the pin. Tighten up the bolts again until the halves of the bearings meet. Now loosen the nuts and, slacking off the outer half of the bearing, remove the lead wires. Measure them at the center for thickness. If more than about 0.0004 in. per inch of pin diameter—that is, for a 10-in. pin the clearance should be 0.004 in.—one or more of the shims that are between the bearing halves at *K* should be removed. The same method is followed in case of the piston pin, except the screw *F* and block *E* are used to tighten the bearing against the shims.



OIL ENGINE CONNECTING ROD ADJUSTMENTS

The pressure on the rod bearings is always on the half of the bearing toward the rod. The adjustment of the clearance will not affect the rod length *L*. However, if there is enough wear to require adjustment for clearance, it is evident that the bearings have worn down and *L* is less than formerly. To bring *L* back to its original length, there should be added at *H* the same thickness of shims as the sum of the shims removed from the crank and piston pin bearings.

Easy Lessons in Engineering

Percentages—Some Pitfalls to Avoid

The expression "per cent" is an abbreviation of the Latin "per centum" which means "per hundred" or "parts per hundred." If 100 lb. of coal contains 20 lb. of ash, we say that the coal contains 20 per cent of ash, meaning that there are 20 parts of ash per 100 of coal. We may also say that the "percentage" of ash is 20.

If 17 lb. of coal contains 2 lb. of ash, we get the percentage of ash by finding how many pounds of ash there would be in 100 lb. of coal. The easiest way to get this is to figure first the weight of ash in one pound of coal as $2 \div 17 = 0.1176$ lb., and then multiply 0.1176 lb. by 100 to get 11.76 lb., the weight of ash in 100 lb. of coal. The percentage of ash is, then, 11.76.

This seems like pretty elementary stuff, but a clear understanding of it would prevent such a wrong statement as the following:

4 lb. of moisture ÷ 40 lb. total weight = 0.1 per cent moisture

This should read:

4 lb. moisture ÷ 40 lb. total weight = 0.1 or 10 per cent moisture.

Whenever one quantity is divided by another, the answer is the number of units of the first for a single unit of the second. This answer must always be multiplied by 100 before the term "per cent" can be applied. While it is not correct to write 0.3 = 30, it is strictly correct to say 0.3 = 30 parts per hundred = 30 per cent, or simply 0.3 = 30 per cent.

One of the most common applications of percentage in engineering is in connection with various "efficiencies." The efficiency of a machine or part of a machine is almost invariably an "output" divided by an "input," where both output and input are measured in the same units. These units may be horsepower, foot-pounds, heat units, kilowatts, etc.

Suppose we wish to figure the efficiency of an electric motor of which the output is 4 horsepower and the input 5 (electrical) horsepower. Then,

Efficiency = output ÷ input = 4 ÷ 5 = 0.8 or 80 per cent.

In this case the efficiency may be called "0.8" or it may be called "80 per cent," the two expressions meaning exactly the same thing. It cannot properly be called "0.8 per cent" or just "80."

Now, as something a little more tricky, consider an example of "per cent increase" and "per cent decrease." If the war caused the price of a certain commodity to increase 50 per cent, it will only have to fall 33⅓ per cent to get back where it started. This is figured as follows, assuming that the original price was $1.

High Price = 50 per cent more than low price = 1.5 × $1.00 = $1.50.

Decrease from high price to low price = $0.50, which is $0.50 ÷ $1.50 = ⅓ = 33⅓ per cent.

The reason the two percentages are not the same is that the increase is based on parts per hundred of the low price, while the decrease is based on parts per hundred of a higher price.

Here again we have something very elementary that must be clearly understood to avoid confusion in more difficult problems. We frequently hear statements equivalent to this: "A certain appliance will increase the over-all efficiency of your plant 25 per cent, and thus save 25 per cent of your coal bill." This is incorrect. It would save less than 25 per cent.

To figure the actual saving, consider that the final output *for a given amount of coal* is 1.25 times the original. Then the final amount of coal *for a given output* will be 1/1.25 or 0.8 of the original amount. Since 0.8 is 80 per cent, the saving in coal must be 20 per cent.

Conversely, a saving of 20 per cent means a gain of 25 per cent in efficiency. The reader can make sure he understands problems of this kind by checking the following statements: 100 per cent gain = 50 per cent saving; 33⅓ per cent gain = 25 per cent saving; 33⅓ per cent saving = 50 per cent gain; 10 per cent saving = 11.11 per cent gain.

So far we have figured our per cent changes as parts per hundred of the original value. Some confusion exists in engineering literature when talking of per cent changes in efficiency because efficiency itself is usually given in per cent. Suppose the efficiency of a steam turbine is increased from 20 per cent to 22 per cent. Strictly speaking, the efficiency has increased 2/20 = 0.1, or 10 per cent of its original value. It is correct to say that the efficiency has increased 10 per cent, but such a change is sometimes referred to as a 2-per cent increase in efficiency.

Unfortunately, this matter has not yet been definitely settled, so that the student of engineering books and periodicals must often read between the lines to see whether the writer means a "flat" change in efficiency (in this case 2 per cent) or an actual per cent change (in this case 10 per cent). Perhaps the most frequent occurrence of the former usage is in connection with boiler efficiencies where it is rather common, for example, to refer to an increase from 60 per cent to 70 per cent as a 10 per cent increase, although the final efficiency is really 16.67 per cent greater than the original efficiency.

In many cases it is easy for a man familiar with the particular machinery under discussion to tell what is meant. For example, if it is claimed that certain changes will increase the efficiency of a turbine or the over-all efficiency of a plant 10 per cent, the reader may safely assume that the increase is 10 per cent of the original efficiency, since a "flat" increase of 10 per cent would ordinarily carry the efficiency beyond the limits of present-day practice.

The Absorption Refrigerating System*

By G. H. PARDEE

WHEN we speak of the efficiency of some machine, it is generally understood that we are referring to the power or fuel consumption of this particular machine and, naturally, we mean maximum output with minimum input. When we speak of economy of such machines, we are speaking in terms entirely different from what is meant when we talk about the efficiency of the machine.

These two terms are frequently misused when one goes into the matter of selecting machinery for various purposes. A machine may be very efficient from the viewpoint of power or fuel consumption and still not be an economical machine to install from the investment viewpoint. Naturally, when one invests in a business he looks for apparatus that will pay the biggest return on the investment in the shortest time. Very often the mistake is made in selecting, at a large first cost, some efficient machine that is not efficient enough to offset the interest on the high initial investment.

Replacement of Equipment

Many times perfectly good machinery is taken out and replaced with other machines which show a better efficiency, but when the final check up is made, it is found that money has been lost by the change owing to the increased investment. When machinery in a plant is in fairly good shape or can be repaired and put in good shape for a nominal sum, it does not always pay to discard such machinery unless the new equipment can show enough saving in its efficient operation to pay somewhat more than the current rate of interest on the investment.

In making a comparison between the efficiency of the absorption and compression refrigerating machines both working under the same conditions, these facts should not be forgotten.

In order that we may have certain conditions on which to base the calculations in this comparison, the following data have been selected, these being about the average to be found in the ordinary plant: A brine temperature of 10 deg. below zero, cooling water for the machines at 70 deg. F., steam to be furnished at 150 lb. gage pressure with no superheat.

To cool this brine a horizontal tubular multipass brine cooler will be used, together with a motor-driven centrifugal pump for the circulation of the brine through the cooler and refrigerating coils. Assuming that 100 tons of refrigeration are needed, with a range of 5 deg. between where the brine enters and leaves the cooler, about 500 gal. of brine per minute must be circulated through this cooler and coils, and in order to do this about 10 hp. will be required by the pump motor. The suction pressure at the machine will be about 5 lb. gage, which will give a 7½-deg. range between the temperature of the brine leaving the cooler and the evaporating temperature of the ammonia in the cooler. This is ample for the heat transfer. How can these conditions be handled by the absorption machine?

Condenser Requirements

By referring to tests and experiments it is found that with 70-deg. cooling water about 3½ gal. of water will be required per ton per minute, and at 100 tons capacity about 350 gal. per min. With cooling water of this temperature the condensing pressure on an atmospheric-type condenser will be about 140 lb. gage. At a condensing pressure of 140 lb. gage about 9 lb. steam pressure is required in the generator coils. By referring to tables on the properties of ammonia liquors it is found that the strength of the liquor from the generator in this case is about 24⅝ deg. Baumé. As experience has proved, in order to do the best results when working under these conditions, there should be a range from 3¾ to 4 deg. Baumé in order to distill off the proper amount of gas; then a strong liquor must be about 28¼ or 28¾ deg. Baumé. By further referring to the ammonia tables on the properties of ammonia liquors, it is found that with 5 lb. pressure and 28¾ deg. ammonia, the temperature in the absorber will be about 88 deg. As the water leaves the absorber at about 82 deg., it can readily be seen that with the proper absorber surface there will be no trouble in maintaining the 5 lb. suction pressure.

Steam Consumption of Absorption System

With properly designed surfaces, the steam consumption of the generator under these conditions amounts to about 31 lb. of steam per ton of refrigeration per hour. Then, at 100 tons capacity the total steam consumption would be 3,100 lb. an hour, since after the expansive force of the steam has been used for the power with which to pump the water and brine, the heat left in the exhaust from these pumps, etc., is used in the ammonia generator to drive off the gas from the aqua ammonia to produce the refrigeration.

This is the principal reason for the efficiency of the absorption machine, and in plants such as packing houses and oil refineries, where there is plenty of exhaust steam available, the exhaust-steam absorption machine holds the record for the highest efficiency and lowest cost of production of refrigeration, on account of the fact that it utilizes exhaust steam that would otherwise go to waste.

Now see what will be required in the line of a compression machine to equal the efficiency of the absorption machine working under the same conditions. The compression machine does not require quite as much cooling water per ton of refrigeration as in case of the absorption machine, being 3 gal. a ton with the compression machine as compared with 3½ gal. with the absorption machine. This is one item in favor of the compression machine.

With 150 lb. boiler pressure and using the most economical pumping equipment that it is possible to install, the steam consumption of the condenser-water pumps per ton of refrigeration delivered amounts to 7½ lb. of steam per ton per hour or 750 lb. an hour at 100 tons capacity.

Comparison With Compression Systems

The next step is to select the most economical compressor that can be had. A two-stage compressor, direct connected to a compound condensing engine taking steam at 150 lb. pressure and exhausting into a 26-in. vacuum, requires 14.7 lb. steam per i.hp.-hr. With the compressor working against 152 lb. condensing pressure and 5 lb. suction pressure, this machine will require 1.78 i.hp. per ton of refrigeration at the engine cylinders. Then, at a steam rate of 14.7 per i.hp. the steam consumption of this compressor will be 26.1 lb. steam per ton of refrigeration per hour, or 2,610 lb. per 100 tons capacity. Adding the 750 lb. per hour required for the auxiliaries makes a total steam consumption of 3,360 lb. an hour or 33.6 lb. steam per ton per hour. With the same machine running non-condensing the steam consumption would be 19.4 lb. steam per i.hp., or 34.5 lb. steam per ton of refrigeration per hour, and with the auxiliaries added, would be 42 lb. steam per ton per hour. So in this case the absorption machine shows a saving of 2.6 lb. of steam an hour over the compound condensing compression machine and a saving of 11 lb. of steam an hour over the compound non-condensing compression machine working under the same conditions.

Cost of Operation

We shall now go into the economy of the two plants based on the foregoing performances. The saving in favor of the absorption machine in comparison with the compound condensing compression machine with coal at $6 a ton would amount to about $80 a month, based on an average evaporation of 7½ lb. of water per pound of coal and operating 30 days a month 24 hours a day. With the compound non-condensing plant the saving would amount to about

*Extract of paper read before the annual meeting of the National Association of Practical Refrigerating Engineers at St. Louis, Mo., Nov. 1, 1922.

$322.50 a month figured on the same basis. This is based on fuel saving alone.

By eliminating the boiler plant and brine cooler from the comparison, because each of these would amount to about the same in both plants, the absorption equipment calls for an investment of about $24,000. The interest at 6 per cent would amount to $120 a month. The compound condensing plant equipment would cost about $20,000. The interest on this investment at 6 per cent would be $100 a month. In the compound non-condensing plant the investment would be $19,000. The interest at 6 per cent would amount to $95 a month. Then the comparison between the absorption plant and the compound condensing compression plant shows about $20 a month in interest in favor of the compression plant and in the case of the compound non-condensing compression plant about $25 a month in favor of this plant. By referring again to the operating cost comparisons, it is found that in operation the absorption machine shows a saving of $80 a month over the compound condensing plant, and after deducting the $20 in favor of the latter plant, the absorption machine has an advantage of $60 a month, and in the case of the compound non-condensing plant there will be a saving of $297.50 a month in favor of the absorption plant.

From these comparisons it will be seen that even at a considerably higher first cost the absorption machine is the most economical machine to install for this class of work or for the production of low temperatures in steam-driven plants.

Maintenance Charges

In the matter of upkeep and repairs there will not be much difference between the two systems. The later types of exhaust-steam absorption refrigerating machines do not deteriorate nearly as fast as did the old-style machine using live steam in the generator at high pressure, because the surfaces that come in contact with the aqua ammonia and that gave out on the old-style machine very frequently, are not subjected to the extreme temperatures that existed in the old-style machine.

This point is considerably in favor of the new-type exhaust-steam machine because it has been the means of decreasing the upkeep cost of the absorption system to a minimum.

In the case of the high-efficiency compression plant, such as will have to be used to compare favorably with the exhaust-steam machine on this class of work, it will be found that in order for this plant to maintain its high degree of efficiency, the upkeep and repairs will be considerably more than what would be the case with the ordinary type of plant.

The type of equipment that these calculations are based on is atmospheric equipment throughout. That is, in the absorption machine, atmospheric absorber, weak-liquor cooler and condenser have been used; in the compression plant atmospheric drip type ammonia condensers have been used. On the engine of the compound condensing compression machine the barometric type of condenser has been assumed.

Another point that should not be overlooked in connection with the absorption machine is that in steam-driven compression ice plants where increased capacity is contemplated, an absorption machine can be installed so as to use the exhaust steam from the auxiliaries or one of the main compressor engines, in the generator of the absorption machine, and by using a raw-water freezing tank making raw-water ice, a considerably increased capacity can be obtained with a very slight increase in the fuel consumption. In one instance of this kind that I can recall, the owners claim they cannot detect any increase in coal consumption when the absorption machine is running, although when the absorption system is in operation 20 tons more ice are produced.

Don't start an ammonia compressor without first making sure that the discharge valve is open. Don't forget to turn the water on the condenser just before or immediately after starting the compressor. Don't forget to watch the head (condenser) pressure when starting. It will warn you of things that are wrong.

Metropolitan Engineers Tackle Firebrick Problems[1]

The subject of refractories touches the average power plant engineer right where he lives, so it is not surprising that the meeting of the Metropolitan Section of the A.S.M.E. held Jan. 23 at the Society headquarters in New York City developed into the liveliest kind of a symposium. While much credit for the success of the meeting must be given to Kenneth Seaver, general sales manager of the Harbison-Walker Refractories Co., for his excellent paper, and for the fund of information which added much to the discussion, the outstanding feature of the meeting was the frank exchange of ideas by the manufacturers and users of refractories, the users getting a new mental picture of both production and application, while the manufacturers had an exceptional opportunity to get the viewpoint of the users.

Referring to the question of uniform size, it was emphasized again and again by the users that the thin joints which seem essential to long furnace life are impossible where the brick varies greatly in size, particularly in thickness. On the other hand, it was generally agreed by all present that a large part of all troubles experienced could be avoided by proper furnace design and construction. In many cases, it was said, slight changes in baffling, bridge walls, secondary-air inlets, etc., had increased the life of the refractories from a few weeks to many months.

Firebrick Manufacture Described

The following are some of the many points that Mr. Seaver brought out in his paper: While many special refractories have been developed in recent years, the power-plant operator must still depend in the main on ordinary firebrick. Even silica brick, which plays such an important part in metallurgical operations because of its stability at high temperatures, is unsuitable for boiler settings on account of its marked expansion and contraction in the lower temperature ranges.

Not only must the needs of power-plant customers be met in the main by firebrick, but most of this brick—due to the commercial impracticability of long freight hauls—must be made from such clay as nature has deposited near the user. This fact makes any nation-wide standardization of material impracticable. The manufacturer, however, can and must study the nature of the clays available in each district, so that, by proper compounding and treatment, he may obtain the best results of which they are capable.

Fireclay, as brought out of the mine, is much less plastic than ordinary clay. Some of it may even be in the form of hard dry lumps. This necessitates preliminary treatment to develop enough plasticity for satisfactory molding, etc. The clay as taken from the storage pile is carefully compounded and then ground wet for a predetermined time. After grinding it is rammed by hand into wooden molds and air-dried in a warm place for from five to ten hours. It is then re-pressed in hand molds to a shape and size calculated to allow for the shrinkage and distortion that occur during the firing process.

As a preliminary to firing, the bricks are stacked up in kilns. This is a matter requiring considerable experience in order to keep to a minimum the distortion of the lower layers that must to some extent result from the weight of those above. The bricks are then fired at white heat for several days, whereupon—after cooling and inspection—they are ready for shipment.

The variations in size found to a greater or less extent in all commercial firebrick are due partly to variation in shrinkage with heat, but more to the effect (already noted) of the varying pressure from layer to layer in the kilns. This problem is further complicated by the multitude of special sizes and shapes demanded by the consumer, as each size and shape is differently affected by the pressure. A more general adherence to a few standard shapes would

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[1]Mention is made of this meeting in the editorial "Co-operation the Key to Firebrick Satisfaction" on page 181 of this issue.

doubtless result in greater uniformity as well as in reduced manufacturing costs.

Aside from the test of actual operation perhaps the best-known test of brick is that in which cones specially molded from the same mixture are compared with standard cones for softening temperature. A similar test can be made by observing the temperature at which a full-sized brick placed on end bends out of shape under its own weight. Engineers are not agreed as to which method is best, but it may be said that each has its place, although neither tells the whole story of the suitability of a given brick for given conditions.

High-temperature cements are frequently tested for softening under pressure by building up an arch made from a single row of bricks bonded with the given cement. If the melting point of the cement is too low, it is squeezed out of the joints when the arch is subjected to the test temperature. Another cement test is to heat up a vertical pile of bricks with cemented joints. High-temperature cements differ greatly in their qualities, so that care is needed in their selection. A poor cement may render the best brick useless.

Refractories differ greatly in their expansion at different temperatures. In the case of silica brick most of the expansion takes place at relatively low temperatures, so that these bricks are rapidly destroyed by frequent heating and cooling in the lower ranges. It thus results that silica brick, which stands up well at the high and continuous temperatures of byproduct coke ovens, are not suited for use in boiler furnaces.

The construction and repair of furnaces has been the subject of much study and experiment. In most cases it has proved possible to overcome the difficulties encountered. For example, one company uses a cement gun every two months to spray the inside of the furnace with a half-inch layer of high-temperature cement and thereby greatly reduces its refractory maintenance expense. There are many cases where the arches over chain-grate stokers have disintegrated rapidly, owing to a combination of pressure and high temperature. In some of these cases the life of the arches has been increased many-fold by the use of relieving arches, and by slight changes in form, location, secondary air openings, etc. Where the arch continually eats away at certain points, the trouble should naturally be sought in improper draft distribution. Center walls are a great source of trouble, since the heat is not carried away as it is in the case of an outer wall. No red brick whatever should be used in the construction of a solid center wall. The only satisfactory solution of center-wall troubles seems to be air cooling.

Paper Starts Lively Discussion

As already stated, this paper "started the ball rolling," and resulted in an exceedingly lively and practical discussion. Among those taking part in the discussion were Edwin B. Ricketts, asst. to chief operating engineer, New York Edison Co.; Warren C. Drake, president of the Drake Non-Clinkering Furnace Block Co.; V. M. Frost, asst. general supt., Public-Service Electric Co.; G. P. Hemstreet, gen. wks. mgr., Hastings Pavement Co.; A. W. Patterson, Jr., vice-president, The Engineer Co. and John H. Lawrence, engineering manager, Thos. E. Murray, Inc.

As one who is making a special study of boiler-wall construction, Mr. Ricketts had come to the conclusion that the power-plant engineer must pass by most of the special bricks that are useful in metallurgical operations, because they cost too much for boiler work. The firebrick used, however, should be of the highest grade. Higher temperatures and, in particular, the introduction of powdered fuel, he said, were introducing troubles that could best be solved by cooling the walls with air, later using this for combustion. The resulting reduction in the penetration of high temperatures would not only greatly reduce the cutting action of the heat, but leave most of the weight supported by brick well below the softening point. Mr. Ricketts, in common with other speakers, emphasized the major importance of uniform size, since lack of uniformity made thick joints necessary, these being the starting point for the destruction of the walls. The ideal was a brick-to-brick contact with only a thin wash of fireclay to fill the pores. Mr. Drake seconded Mr. Rickett's plea for more uniform brick and called attention to the difficulty of combining large furnace blocks with bricks of varying thickness. He suggested the adoption of standard specifications to cover both the size and the bonding of the bricks in relation to each other in the furnace wall.

In re-emphazing the importance of uniformity, Mr. Frost said that 90 per cent of furnace work was repair work and that lack of uniformity greatly increased the cost of repairs.

Baffling Affects Life of Firebrick

Mr. Hemstreet recommended that the brick be passed to the mason by a helper equipped with a gage to cull the bricks to the desired size. That the arrangement of the baffles often had a marked influence on the life of the furnace was the conclusion that Mr. Hemstreet drew from his extensive experience along this line. The idea was to so baffle as to keep the velocities low through the first rows of tubes and to expose as much tube surface as possible to the radiant heat. The reason is that the absorption of radiant heat appreciably lowers the temperature of the furnace walls and that too great a velocity of the gases entering the tubes leads to slagging and rapid reduction of their power to absorb radiant heat. He also suggested the use of larger "shapes" to reduce the number of joints.

Mr. Lawrence remarked that the fire-brick manufacturer is often blamed for troubles that are not due to the quality of the firebrick.

In reply to questions Mr. Seaver said that it did not appear commercially possible to make a non-expanding brick that combined suitable refractory qualities with reasonable price. He also said that it was impossible to manufacture firebrick to extremely close limits of size chiefly on account of the varying distortion in different layers in the kiln. It was, of course, possible to supply any customer with brick of uniform thickness by the simple process of culling, but this seemed to be commercially impracticable on account of the difficulty of disposing of the various culled sizes.

Expect Large Saving from Centralizing Federal Plants

Extension of the United States Capitol power plant to provide heat, light and power for the Government Printing Office, the Botanical Garden and the Washington City post office, in addition to the buildings already included in its service, was announced in *Power* for Oct. 10, 1922, on page 587. Previous estimates that this extension would effect a saving of approximately $100,000 a year have been revised to more than double this sum.

Testimony before the House Appropriations Committee shows that various bureau chiefs interested in this change estimate that there will be saved approximately 15,000 tons of coal annually, at an average cost of $8 per ton, or an aggregate of $120,000 in the fuel item alone; approximately $60,000 in labor now required by separate plants, and about a million gallons of filtered water daily to the District of Columbia. This water item will mean an indirect saving of around $37,000 a year and will provide a great relief for the District water plant, which is heavily overburdened.

The additional load will be taken over by the Capitol plant about April 1, according to the rate of installation of the sixteen new boilers. The tunnels connecting the city post office and the printing office on one leg and the Botanical Garden on another are practically completed.

The cost of the Botanical Garden connection, originally estimated at $20,000, has been doubled owing to a change in plans. The entire system of heating the greenhouses is to be changed from live steam to a hot-water system, giving a slower and more easily controlled heat for this purpose.

Congress has approved an appropriation of $14,000 for the installation of steam-flow meters to measure the service to each of the buildings served by the Capitol plant and also to check the efficiency of the new boilers. Heretofore, charges against the buildings have been estimated by water consumption.

News in the Field of Power

Coal Commission Preparing for Second Report

With its preliminary report to Congress out of the way, the United States Coal Commission is now collecting data for its second report, which, it is expected, will be submitted to Congress on or about March 15.

This report will include such matters as miners' wages, earnings and mining conditions, not covered in the preliminary report because of lack of time. The report to follow the one in March will, it was said, probably cover profits which, according to Chairman Hammond, is an almost "endless study."

The commission is now getting data from wholesale dealers in coal throughout the country, touching upon the amount of bituminous and anthracite handled, reports of the mines, the freight charges, wholesale price and gross margin.

Warns Against Adulteration of Coal

As a matter of timely interest to prospective purchasers of coal and a warning that purchasers should assure themselves of the responsibility and standing of concerns offering coal for sale and shipment, the Federal Fuel Distributor has announced the receipt of reports telling of several shipments of "anthracite," largely composed of slate, bone, clinkers and other foreign matter, apparently made by irresponsible and unscrupulous people. Assuming the accuracy of these reports, says the Fuel Distributor, such acts constitute not only a violation of the law, but indicate a particularly heartless attitude on the part of those guilty, in taking advantage of the public during the national emergency in fuel supply.

Correspondence between the Federal Fuel Distributor and D. B. Ainey, chairman of the Pennsylvania Fuel Commission, indicates that investigations of the activities of shippers of adulterated coal are being made and that the legal aspects of the whole matter are being looked into.

To Reward Best Student in N.E.L.A. Study Courses

As a means of stimulating educational activity among the employees of member companies of the N.E.L.A., Frank W. Smith, president of the association, has offered an annual prize of $100, to be presented at the N.E.L.A. convention to the individual who has done the best work in one or more of the study courses given by the educational committees of the Commercial and Accounting National Sections. These courses, seven in number, open the way for young men and women in the central-station industry to advance their study and application, thus benefiting themselves and giving to the industry the potential leaders so necessary to its future development.

Details of the rules governing the competition and award, now being worked out by the Educational Committee, will be published later.

Arizona Opposes Colorado Compact

Opposition to the ratification of the Colorado River compact has gained considerable headway in Arizona. It is believed, however, that Arizona will ratify the compact ultimately, as the pressure which would be brought upon the oppositionists would be great. Not only would this pressure come from all the interests in the basin anxious to begin the utilization of the river's resources, but from the people of the lower valley whose protection from floods awaits the ratification of this peace treaty.

Highest Powered Naval Ship To Undergo Trial Run

Preliminary acceptance trials of the scout cruiser "Omaha," highest powered vessel ever built for the United States Navy, will be run on Jan. 30 at Tacoma, Wash.

A remarkable feature of the "Omaha" is the enormous power of her four Westinghouse turbines. When operating at full capacity, these turbines will develop a total of 90,000 hp. The turbines of the "Majestic," the largest steamship in the world, develop 100,000 hp., but the "Majestic" is nine times larger than the "Omaha."

However, the "Omaha" needs 90,000 hp. only when she is tearing through the water at the express-train rate of 35 knots, or 42 miles an hour. For ordinary cruising speeds of from 12 to 15 knots, a few thousand horsepower is sufficient. In this connection it must be remembered that the power required increases as the cube of the speed. In order to avoid operating the "Omaha's" big turbines at so small a fraction of their rated capacity, four small cruising turbines are provided.

The "Omaha" was built at the plant of the Todd Shipyards Corp., and is the first of ten vessels of her type, having a maximum speed of 35 knots, a displacement of 7,500 tons and batteries of twelve six-inch guns. The trial run, over the Vashon Island course in Puget Sound, will last six hours.

Largest Frequency Changer for Brooklyn Edison

The Brooklyn Edison Co. has purchased a Westinghouse frequency changer set of 35,000 kva. capacity for installation in its Gold Street station. The set is larger than any frequency changer set now in service in the United States and has over-all dimensions, including the direct-connected exciter, of approximately 47½ ft. in length, 22 ft. in width and 15 ft. in height. It is expected that it will be in operation by November.

The set, operating at 300 r.p.m., will connect the company's 25-cycle and 60-cycle systems, transforming energy from 13,800 volts three-phase 60-cycle, to either 6,600 volts or 11,400 volts three-phase 25-cycle. The 60-cycle end of the set is connected directly to an auto transformer, through which the voltage is stepped up from 13,800 to 27,600. At this end a tie line, running underground in three-phase lead-covered cables, will connect the set with the new Hudson Avenue power house.

The high efficiencies of the frequency changer set and of the new generating units for the Hudson Avenue station make it more economical to generate power at 60 cycles in this station, transmitting it to Gold Street and converting to 25 cycles through the frequency changer, than to generate the 25-cycle current directly, using some of the older machines now in operation in the Gold Street station.

Ireland Plans Water-Power Developments

An opportunity for the sale of American power-house and transmission equipment is seen by *Commerce Reports* in the plan of the newly organized Irish Power Syndicate to develop water power at two sites on the Liffey River, in County Kildare, Ireland, about twenty-five miles southwest of Dublin. It is proposed to convey power from these stations by overhead transmission lines to the boundaries of Dublin and thence underground into the city. The syndicate intends to supply power to authorized distributors along the route of the transmission line and in the districts of Dublin that do not now have electric-power facilities.

The new company, with headquarters at 28 Molesworth St., Dublin, has applied to the Minister of Industry and Commerce of the Irish Provisional Government for a special order to enable it to acquire sites for power stations and rights-of-way for transmission lines. The available power at the Liffey River is estimated at 8,300 hp. if the six sites suitable for generating

plants are fully developed. Opposition so slight as to be almost negligible is being encountered from those opposed to private development of water-power.

Novel Irrigation Project

Would Lift Water 771 Ft. from Deschutes River for Irrigation

A PROJECT to irrigate 83,000 acres of land in central Oregon by pumping water an average lift of 771 ft.—said to be a proposal without parallel in the development of irrigation farming in the United States—formed the basis of an exhaustive hearing granted by the Federal Power Commission to representatives of the Bend Water, Light & Power Co., of Bend, Ore., and the Columbia Valley Power Co., rival contenders for the Metolius site on the Deschutes River.

It seems probable that the Federal Power Commission will reject the proposition of the Bend company and will execute the preliminary permit for power rights requested by the Columbia Valley Power Co. This permit was authorized by the commission on Oct. 10, 1922, but its execution was withheld when the Bend company, backed by an unusual volume of local sentiment, filed a belated application.

Attack Commission's Conclusions

At the hearing the Columbia Valley company's representatives stated that they would make no argument as they are entirely willing that the question be settled on its merits. Engineers of the Reclamation Service join with those of the Federal Power Commission in concluding that the irrigation project was not feasible. The Bend company devoted practically all of its two hours to an attack on the conclusions of the engineers of the Power Commission. The reflection on the Commission's engineers became so pointed that Secretary Weeks declared he would tolerate no further aspersions on the motives or fair-mindedness of the Commission's engineers.

Col. William Kelly, chief engineer of the Commission, pointed out that by making every possible allowance for the cheap power furnished by the Deschutes, it would be impossible to bring power costs below $3 per horsepower-year. The engineers of the Bend company had arrived at a much lower figure for the cost of the power. Before a decision is made by the Commission, these engineers will confer with Colonel Kelly in an effort to justify their figures.

Predict Industrial Use of Oxidized Kerosene

The solution of still another industrial problem has been undertaken at the research laboratories of Carnegie Institute of Technology, Pittsburgh, in experiments to determine the relative efficiency of kerosenes and oxidized kerosenes as fuels. According to a report by Dr. J. H. James, head of the department conducting the experiments, oxidized kerosene—manufactured by catalytic oxidation from low-grade petroleum—cause less "knocking" tendencies than straight kerosene when used in a kerosene engine. The tests showed also that oxidized kerosenes develop approximately the same power as ordinary kerosene, in spite of the fact that their thermal value is one-eighth less. Dr. James attributes this to the better "clean up" in the combustion of these partly oxidized fuels. The success of the experimental work at Carnegie at this stage gives promise that oxidized kerosene may be used industrially in kerosene engines or blended with gasoline for use in gasoline engines.

Colorado Plant Will Burn Powdered Coal

On Boulder Lake, an artificial reservoir high in the mountains of Colorado, will be located the largest steam plant ever built on an artificial body of water in this country, according to plans recently made public. The plant will burn powdered coal from the mines of the vicinity, and will be built by the Denver Gas & Electric Light Co. and the Western Light & Power Co., members of the Doherty Cities Service group.

The lake, covering 128 acres and impounding about 78,000,000 cu.ft. of water at present, will be enlarged to cover 380 acres and to impound 280,000,000 cu.ft. Located four miles south of Boulder, the new plant will serve Denver, Boulder, Lafayette, Fort Collins, Greeley and all intermediate cities and surrounding towns, as far north as Cheyenne, Wyo. The present plans are for a generating capacity of 120,000 hp., the possible ultimate rating being put at 250,000 hp. The old plant at Lafayette will be abandoned.

While an immediate expenditure of $4,000,000 for plant and equipment is planned, the ultimate cost may run up to $12,000,000. It is said that the plant will be ready to supply the larger cities in its territory early in 1924.

B. G. Lamme Presented with Sullivant Medal

The many notable engineering achievements of Benjamin G. Lamme, chief engineer of the Westinghouse Electric & Manufacturing Co., were officially recognized on Jan. 12, when he was formally presented with the Joseph Sullivant medal by his alma mater, Ohio State University.

Mr. Lamme, who was graduated from Ohio State in 1888, is the first person to receive the Joseph Sullivant medal, which will in the future be awarded once in every five years for an admittedly notable achievement on the part of a son or daughter of the university, in the fields of literature, philosophy and art as well as in science and engineering.

The medal, established by Dr. Thomas Corwin Mendenhall, professor emeritus of physics at Ohio State, is awarded in honor of Joseph Sullivant, who "as a member of the first board of trustees, was more influential than any other person in determining the character and future of the university at the most critical period in its history."

Hears Louisville Case

City and Utility Contend for Ohio Power —Commission May Delay Decision For One Year

JUDGING from the arguments presented at a hearing before the Federal Power Commission and by the apparent attitude of Secretary Weeks, its chairman, the probabilities favor an ultimate award for the Louisville Hydro-electric Co. in its conflict with the City of Louisville for power rights at the Falls of the Ohio. The Louisville Hydro-electric Co. is a subsidiary of the Louisville Gas & Electric Co., a Byllesby interest.

Owing to the preference given municipalities in the water power act, it is not likely that the Federal Power Commission will decide immediately in favor of the Louisville Hydro-electric Co. It is probable that a year or some such length of time will be allowed the city to attempt to secure the necessary authority to embark in this business enterprise.

Position of the City

The city was represented by former Governor Thatcher and by Gen. William L. Seibert, the constructor of the Gatun Dam. In their arguments it was brought out that the City of Louisville proposes to develop this power through its water company, a private corporation, but all of whose stock is owned by the city. It is the intention of the city's company to supply power to the entire tributary region, including that which lies adjacent to Louisville in Indiana. The city's plan is to develop 75,000 to 100,000 hp. To do this it is planned to develop steam auxiliaries or to erect an auxiliary power plant on either the Green or the Cumberland River. A preliminary study has been made and the plan has been declared to be feasible. Under the worst condition of drought a constant source of power may be had by operating plants on the Ohio and on one of the other rivers mentioned. The point was made that the city is anxious not to interfere with the existing business of the Louisville Gas & Electric Co., and it was contended that the city's development would take care of the market over and above that enjoyed by the existing company.

The Utility's Arguments

The arguments for the Louisville Hydro-electric Co. hinged on the fact that it already has a development of 60,000 hp. provided by an existing steam plant and has in construction a new unit which will furnish an additional 30,000 hp. of steam power. With

this installation it is in a position to make the best use of the variable power developed at the Government dam, it was contended. Moreover, it was pointed out that the public-utility company has a complete distributing system serving not only Louisville but the entire surrounding region.

Talk Both Ways by Radio Over Power Lines

Before representatives of all the larger light and power companies of the United States a new use of radio was brought to light recently, when it was demonstrated that voice conversations could be carried on by means of radio waves over high-tension power lines in both directions without the use of switches. It was also demonstrated that this system could be used for remote control of all manner of apparatus.

The new system was demonstrated over a 66,000-volt line and is unique in that the system is duplex and operates as does the ordinary telephone. When the telephone receiver is unhooked, the transmitting station automatically starts up, allowing talk in both directions without any switching. This feature is entirely new in radio as all other transmitting and receiving must be done by switching back and forth, because a station transmitting will not receive messages.

The calling or ringing of numbers is selective and operated by special selector keys which cause the bell to ring only at the station desired. This eliminates the distractive code ringing and allows station operators to keep their minds on their work.

The test was carried out between experimental stations in the Colfax and Brunots Island power stations of the Duquesne Light Co., about thirty miles apart, by engineers of the Westinghouse Electric & Manufacturing Co. and the power company. For a long period the Westinghouse company has been working on a method of carrier-current control for use in central power stations and electric railways, or other points using high-tension electrical lines. The idea behind the whole scheme is to superimpose radio waves on the power lines and thus make use of radio transmitting and receiving for both voice communication and control of remote switches.

New Publications

Mechanical World Year Book, 1923. Published by Emmott & Co., Ltd., 65 King St., Manchester, England. Cloth, 4x6 in.; 215 pages, including advertisements. Price, 1s. 6d.

Of the new matter to be found in this thirty-sixth annual edition, the section devoted to fan work deserves first mention. The section on safe loads and deflection of beams has been rewritten and new illustrations prepared. The notes on belting have been extended, and revisions effected in various other sections. Among the new tables is one giving the length of diagonals of certain sections and a revised table of gaging.

Fuel Oil in Industry. By Stephen O. Andros. Published by Petroleum Extension University, Fort Wayne, Ind. Second edition. Cloth, 6x9 in.; 203 pages. Price, $3.75.

A short general discussion on heating residences, apartments and hotels with fuel oil has been added to this revised edition, the main body of which covers the combustion of fuel oil and its application to power generation, the manufacture of iron and steel, the sugar and glass industries, the ceramic industry, and to steam navigation, locomotives, heat treating and gas making.

Coming Conventions

American Boiler Manufacturers' Association; H. N. Covell, 191 Dikeman St., Brooklyn, N. Y. Winter meeting at New York City, Feb. 12.

American Institute of Electrical Engineers, 29 West 39th St., New York City. Mid-winter convention at New York City, Feb. 14-17.

Universal Exposition of Inventions and Patents, Grand Central Palace, New York City, Feb. 17-22.

American Institute of Mining and Metallurgical Engineers, 29 West 39th St., New York City. Annual meeting at New York City, Feb. 19-21.

American Society of Mechanical Engineers, 29 W. 39th St., New York City. Pacific coast regional meeting at Los Angeles, Apr. 16-18; spring meeting at Montreal, Canada, May 28-31.

American Association of Engineers, 63 East Adams St., Chicago, Ill. Annual convention at Norfolk, Va., May 7-9.

National Electric Light Association; M. H. Aylesworth, 29 West 39th St., New York City. Annual meeting at New York City, June 4-8.

Business Notes

The Liptak Fire-Brick Arch Co., having outgrown its Minneapolis quarters, has moved to Chicago and on Feb. 1 will open new offices at Twentieth and Prairie Ave.

Elliott Company, Jeannette, Pa., is now handling both the manufacture and sale of Lagonda grease extractors and double automatic and non-return valves, formerly products of the Lagonda Manufacturing Co., Springfield, Ohio.

Trade Catalogs

Protection of Pipe Against Internal Corrosion—National Tube Co., Pittsburgh, Pa. Bulletin 3C, going considerably into the theories of corrosion and recommending the deactivation of water for steam heating and power plants as a means of pipe protection against corrosion.

Portable Electric Tools and Shop Equipment—Black & Decker Manufacturing Co., Towson Heights, Baltimore, Md. A handsome catalog of Black & Decker portable electric drills, screw drivers and socket wrenches, coal-drilling outfits, bench and post drill stands, portable and bench grinders and the "Lectroflater" electric compressor. Of especial value is the section on "How To Grind Drill Bits."

Baffle Walls—The Engineer Co., 17 Battery Place, New York City. "The Turner Baffle Book," showing the construction and application of Turner baffles and curtain walls. The section entitled "Typical Installations," shows clearly how baffles are used in a number of oil- and stoker-fired water-tube boilers.

Superheaters, Waste-heat Type for Marine Boilers—Power Specialty Co., 111 Broadway, New York City. Catalog M4, showing the marine applications of the Foster waste-heat superheater, consisting of steel tubes covered with cast-iron rings. A partial list of ships fitted with these superheaters is given, and there are tables of the composition and calorific values of oil fuel, the relative fuel values of coal and oil, the properties of steam, data for fuel oil at 60 deg. F., and the steam-carrying capacity of extra-heavy steam pipes.

Fuel Prices

BITUMINOUS COAL

The following table shows the trend of the spot steam market in various coals (mine run bases, f.o.b. mines):

Coal	Market Quoting	Jan. 15, 1923	Jan. 22 1923
Pool 1,	New York	$5.50–6.00	$5.50–6.00
Smokeless,	Columbus	6.50–6.75	6.50–6.75
Clearfield,	Boston	4.50–5.25	4.50–5.00
Somerset,	Boston	4.75–5.50	4.75–5.25
Kanawha,	Columbus	3.50–4.00	3.25–3.50
Hocking,	Columbus	3.00–3.25	2.75–3.00
Pittsburgh No. 8	Cleveland	3.35–3.50	3.50–3.75
Franklin, Ill.,	Chicago	3.75–4.00	3.75–4.00
Central, Ill.,	Chicago	3.25–3.75	2.75–3.00
Ind. 4th Vein,	Chicago	3.50–3.75	3.50–3.75
West Ky.,	Louisville	3.35–3.75	2.50–2.75
S. E. Ky,	Louisville	3.00–4.00	3.00–3.25
Big Seam,	Birmingham	2.25–2.50	2.25–2.50

FUEL OIL

(f.o.b. city unless otherwise specified)

New York—Jan. 25, Port Arthur light oil, 22@25 deg. Baumé, 4⅞c. per gal.; 30@35 deg., 5¼c. per gal., f.o.b. Bayonne, N. J.

Chicago—Jan. 13, for 24@26 deg. Baumé, $1 per bbl.; 32@36 deg., 3c. per gal. in tank car.

Philadelphia—Jan. 22, 26@28 deg. Baumé, Oklahoma, 95c.@$1 per bbl.; 30@34 deg., Oklahoma (group 3), 2¾@3c. per gal.; 16@20 deg. Seaboard, $1.30@$1.40 per bbl.

St. Louis—Jan. 15, Oklahoma, 24@26 deg., 95c. per bbl.; 26@28 deg., $1 per bbl.; 28@30 deg., $1.05 per bbl.; Gas oil 32@36 deg., 3c. per gal.; 36@40 deg., distillate, 3½c. per gal.

Pittsburgh—Jan. 9, f.o.b., refinery, Penn., 36@40 deg., 5½@5¾c. per gal.; Kentucky, 26@30 deg., 4c.; Gas oil, 32@36 deg., 2¼@2¾c.; 36@38 deg., 2½@3c.; 38@40 deg., 90c.@$1.05 per bbl.

Dallas—Jan. 20, 26@30 deg., $1.30 per bbl.

New Plant Construction

PROPOSED WORK

Ala., Florence—The U. S. Engineer Office, will receive bids until Feb. 12 for furnishing and delivering electric generator, 937.5 kva. capacity with direct connected exciter.

Ariz., Phoenix—G. H. N. Luhrs, Commercial Hotel, will soon award the contract for an 11 story office building, including modern lighting equipment, compressed air machine, etc., on Jefferson St. and Central Ave. Estimated cost $500,000 to $750,000. Trost & Trost, 2 Republics Bldg., El Paso, Tex., Archts.

Calif., Antioch—The city is having plans prepared for improvements to waterworks, including 500,000 gal. settling basin, 100,000 gal. coagulation basin, and c.i. outside piping; also repairs to present filtration system and installation of 2 pumps. C. F. Smith, 7 Nottingham, Berkeley, Engr.

Calif., Azusa—The Azusa Ice & Cold Storage Co., plans to rebuild a part of its ice manufacturing and cold storage plant, destroyed by fire in December. Estimated cost $100,000. Architect not announced. Power house equipment and some new ice manufacturing equipment will be installed.

Calif., Elmhurst (Oakland P. O.)—The E. H. Neilson Co., 16 California St., San Francisco, will soon receive bids for boiler plant equipment, including boilers, pumps, motors, piping and complete electrical installations, etc., in connection with fruit packing plant, here.

Calif., San Francisco—E. Tropp & W. C. Crittenden, 129 Sutter St., are having plans prepared for the construction of a 16 story, 170 x 229 x 100 ft. hotel and stores building on Market, Hyde and Fulton Sts. Estimated cost $2,000,000. MacDonald & Couchot, 345 Pine St., Archts. Equipment detail not reported.

Colo., Denver—The Regents of the University of Colorado, C. W. Mills. Chn. Bldg. Com., will receive bids until March 1. at office of Briscoe, Fisher & Fisher, Engrs., 731 U. S. Natl. Bank Bldg., for the construction of the School of Medicine, Hospital and Nurses Home, including heating, electrical work, etc., on 8th Ave. and Colorado Blvd.

Conn., Bridgeport—The New Haven Dairy Co., 201 Hazel St., New Haven, plans the construction of a 3 story, 75 x 85 ft. ice cream plant, on Garden St. and South Ave. Estimated cost $150,000. F. E. Brown, 11 Autumn St., New Haven, Archt. Ice cream manufacturing equipment etc. will be required.

Del., Selbyville—The Delaware Light & Ice Co., is in the market for ice manufacturing machinery.

Fla., Miami—The city authorized election to vote $750,000 bonds for waterworks extensions, including filtering plants, new wells, pumping stations, etc. J. G. White Engr. Corp., 43 Exchange Pl., New York, Engrs.

Ill., Champaign—The Sanitary Dist. plans the construction of a sewage disposal plant, including the installation of Imhoff tanks and sprinkling filters. Estimated cost $500,000. Pearse, Greeley & Hansen, 39 West Adams St., Chicago, Ill., Engrs.

Ill., Chicago—Newhouse & Bernham, Archts., 4630 Prairie Ave., are receiving bids for the construction of a temple and community house, including steam heating system, on 50th St. and Drexel Blvd. Estimated cost $800,000. Owner's name withheld.

Ill., Chicago—The U. S. Wet Wash, 7200 South State St., is in the market for a 50 hp. high speed steam engine, 100 lb. pressure.

Ind., Logansport—The Northern Indiana Power Co. is in the market for two 500 hp. boilers and two 10,000 kw. turbines.

Ind., South Bend—Robertson Bros., 127 South Michigan St., plans the construction of an 8 story, 100 x 150 ft. department store, including steam heating system. Estimated cost $500,000. W. M. Elwood, Archt.

Kan., Alma—The city, C. O. Nelson, Clk., will receive bids until February 8 for the construction of waterworks system, including 30,360 ft. of 2 to 6 in. c.i. pipe, hydrants, gate valves, etc., 50,000 gal. reservoir well, pump house and 125 g.p.m. triplex, motor driven pump or 125 g.p.m. centrifugal pump and motor; sanitary sewer system, including disposal plant, Imhoff tank, sludge bed, filter beds, etc. E. T. Archer & Co., 612 New England Bldg., Kansas City, Mo., Consult. Engrs.

Kan., Pittsburg—The city, L. Boyd, Clk., will receive bids until February 7, for the construction of intercepting sewers, sewage pumping station and sewage disposal plant, including vit. pipe, incinerator, c.i. force main; sewage plant to house one 750 gal. per min. and two 1,000 gal. per min. motor driven centrifugal pumps, together with control apparatus, etc.; also distribution system in sprinkling filter, etc. Black & Veatch, Mutual Bldg., Kansas City, Mo., Engrs.

Md., Baltimore—The city council, City Hall, plans the construction of a 4 and 5 story City College on 33rd St. Estimated cost $1,250,000. Architect not selected.

Mass., Somerville—The P. P. Plowide Refrigerator Co., 15 Glen St., is in the market for 550 volt alternating current motor.

Mich., Detroit — E. M. Statler, Statler Hotel, Washington Blvd. and Park Ave., plans the construction of an 18 story, 165 x 300 ft. hotel, including steam heating system and complete electrical equipment, on Woodward Ave. Estimated cost $9,000,000. Architect's name withheld.

Mich., Saginaw — H. W. Sullivan, 1622 North Michigan Ave., is in the market for 500 to 600 kw. a.c. engine generator set, preferably Ball engine or equal, 440 volt, 3 phase, 60 cycle, 120 lb. steam pressure, 5 lb. back pressure, must be direct connected outfit, spring delivery, modern outfit, quote switchboard separately.

Minn., St. Paul—The Ford Motor Co., Highland Park, Mich., is having preliminary sketches prepared for the construction of a manufacturing plant here, including steam power house, etc., on St. Catherine and Cleveland Aves. Estimated cost $10,000,000. A. H. Stem, 601 Endicott Bldg., Archt.

Mo., Kansas City—The American Ice Co., Agnes Ave. and Gilmotte St., is having plans prepared for the construction of a 2 story, 80 x 127 ft. ice plant at 4730 Tracy Ave. Estimated cost $75,000. G. Carman, 406 Gumbel Bldg., Archt. Owners will soon be in the market for new ice manufacturing equipment and machinery for handling ice.

Mo., Kansas City—Rollins & Co., 521 Railway Exchange Bldg., is in the market for ice making machinery and new equipment.

Mo., Leeds—The Blue Valley Ice & Storage Co. is having plans prepared for the construction of 2 story, 70 x 80 ft. ice manufacturing plant, 32 x 80 ft. cold storage unit and a 35 x 81 ft. engine room. H. Von Unwerth, 509 Finance Bldg., Kansas City, Archt.

Mo., Osceola—H. L. Mullergren, Engr., 555 Gates Bldg., Kansas City, will prepare plans for a hydro-electric power plant to be constructed here. Estimated cost, $500,000. Owner's name withheld.

Neb., Davenport—The city will soon hold election to vote $25,000 bonds for the construction of a new waterworks system, including tank and tower and installation of pumps, mains, hydrants, valves, etc. Prince-Nixon Engr. Co., 501 Peters Trust Bldg., Omaha, Engrs.

N. J., Trenton Junction—Guilbert & Betelle, 546 Broad St., Newark, and A. H. Moses, 415 Market St., Camden, Archts., will receive bids until Jan. 31, for the construction of a group of buildings and a transformer house for the State School for Deaf. Estimated cost $300,000. Separate bids will be received for heating, plumbing and electrical work.

N. J., Trenton—The Bd. Educ., R. C. Belville, Secy., 9 South Stockton St., will receive bids until Feb. 5 for the construction of a 2 story, 331 x 368 ft. high school, on West State St. Estimated cost $1,000,000. J. Osborne Hunt, 219 East Hanover St., and E. Sibley, Edgewood Lane, Palisade, Archts. Equipment detail not reported. Noted Oct. 31, 1922.

N.Y., Brooklyn—M. W. Del Gandio, Archt., 160 West 45th St., New York, is preparing plans for a theatre building, 2500 seating capacity, on 86th St., here. Estimated cost $500,000. Owner's name withheld. Equipment detail not reported.

N. Y., Chelsea—The Treasury Dept., J. A. Wetmore, Super. Archt., Wash., D. C., will receive bids until Feb. 7 (change of date) for mechanical equipment (exclusive of outside services, elevators, lighting fixtures and certain equipment) for the administration building and mess hall and kitchen building at the U. S. Veterans' Hospital, here. Noted Sept. 26, 1922.

N. Y., Elmira—S. S. Sittenfield, 468 East Water St., is in the market for a 20 to 25 hp. steam engine, (new or used).

N. Y., Jamestown—The Jamestown Chair Co., 20 Winsor St., plans the construction of a 25 x 75 ft. power house. Estimated cost $25,000. W. Brooks, c/o Owner, Engr. Equipment will be installed.

N. Y., Newark—The Newark Ice & Cold Storage Co. is in the market for cold storage and ice making machinery and equipment for proposed plant to have 60,000 bbl. capacity.

N. Y., Oneida—The common council will receive bids about Feb. 1, for the construction of a sewage disposal plant, including pumping plant, 1350 ft. 24 in. trunk sewer and installation of Imhoff tanks. Estimated cost $60,000. J. M. Hutton, City Engr.

N. Y., Oswego—The Netherlands Company, Inc., is in the market for cold storage and milk pasteurization equipment.

N. Y., Marcy—The State Hospital Comn., Capitol, Albany, will receive bids until Feb. 14, for the construction of a 1 story 65 x 192 ft. addition with second story wing, 32 x 125 ft., at the Marcy Division of the Utica State Hospital, here. L. F. Pilcher, Capitol, Albany, State Archt. Equipment detail not reported.

N. Y., Watertown—The Consumers Brewing Co., c/o W. Cain, Adams, plans the construction of a cold storage plant, here. Estimated cost $40,000 to $50,000. Machinery and equipment will be installed.

Ohio, Akron—The Northern Ohio Traction & Light Co., Terminal Bldg., and the Cleveland Illuminating Co., will soon receive bids for the construction of a high tension electric circuit from here to Cleveland. Estimated cost $700,000. W. G. Tighe, Engr.

Ohio, Akron—The United Cigar Stores Co., 44 West 18th St., New York, will receive bids until February 5 for the construction of an 8 story, 50 x 100 ft., office building on Main and Market Sts., here. Estimated cost $800,000. Sommerfeld & Stechler, 31 Union Sq., New York, Archts. Equipment detail not reported. Noted Dec. 26, 1922.

Ohio, Bremen — Brandt & Hollerbaugh, 303 Commerce Bldg., Columbus, F. D. Brandt, Purch. Agt., are in the market for a 1,250 gal. per min. pump and 2 mixers for stucco manufacturing plant near here.

Ohio, Columbus — Medick-Barrows Co., 135 East Gay St., C. T. Anderson, Asst. Secy. and Treas., is in the market for transformer and 54 in. cutter for photo supply factory.

Ohio, Conneaut—The city plans the construction of a municipal power and lighting plant on the Lakeshore, adjoining waterworks site. Estimated cost $309,565. W. D. Spengler, Hanna Bldg., Cleveland, Engr.

Ohio, Dayton—The Cooper Medicine Co., East 3rd St., plans the construction of a 10 story mercantile and office building, on 1st and Main Sts. Estimated cost $750,000. Architect not selected.

Ohio, Dayton—The Johnson-Watson Co., 131 East 3rd St., plans the construction of a 6 story printing plant. Estimated cost $500,000. Architect not selected.

Ohio, Delaware—The city, W. H. Duffy, Dir. of Service, City Hall, Columbus, will soon receive bids for two 500 gal. per min. vertical, motor driven centrifugal pumps, 1 duplex steam pump, 500 gal. per min. capacity, for waterworks department of the Girls' Industrial Home, Concord.

Ohio, Youngstown—E. Salow, c/o Hotel Salow, plans to reconstruct hotel, recently destroyed by fire. Estimated cost $300,000. Architect not selected.

Okla., Pauls Valley—The city voted $188,000 bonds for water purification plant, pumping station and waterworks extension. Estimated cost of power plant equipment $53,000. V. V. Long & Co., 1300 Colcord Bldg., Oklahoma City, Engrs.

Pa., Ambridge—C. Kristufek, 300 Park Ave., is in the market for air compressor conveying machinery, hoisting machinery, woodworking, transmission and cement block machinery, for planing mill and cement block plant.

Pa., Bethlehem—The Allentown Bethlehem Gas Co. is having plans prepared for the construction of a 1 story liquid purification plant of about 8,000,000 cu.ft. capac-

ity, including patent combinations, absorber and actilier and 15, 20 and 25 hp. motors. Estimated cost $55,000. Koppers Co., Union Arcade, Pittsburgh. Engrs.

Pa., Creighton — The Pittsburgh Plate Glass Co., 1600 Frick Bldg., plans the construction of a manufacturing plant. Estimated cost $3,000,000. Architect not selected.

Pa., Oil City—The Bd. of Educ. will receive bids until Apr. 1, for the construction of a Junior High School on Mylan, Harriot and Washington Aves. Owner is in the market for boilers and ash handling equipment. Estimated cost $500,000. E. E. Bailey, Archt. Noted Oct. 31, 1922.

Pa., Phila.—The Southwark Ice Co., 12th and Washington Sts., is in the market for additional refrigerating and ice manufacturing machinery.

Pa., Phila.—C. E. Wunder, Archt., 1415 Locust St., is receiving bids for a 7 story, 95 x 276 ft. factory, on Water, Swanson and South Sts., for the American Bag & Paper Co., 2nd and Vine Sts. Estimated cost $600,000. Equipment detail not reported.

Pa., Pittsburgh—The Bd. Educ. will receive bids until February 1 for the construction of a 3 story, 148 x 302 ft. addition to high school on Margarette and Beatty Sts. Estimated cost $500,000. E. B. Lee, Chamber of Commerce, Archt. Equipment detail not reported.

Pa., Pittsburgh—E. J. Riffle, Olini Bldg., plans the construction of a 5 story, 85 x 85 ft. apartment building on North Highland Ave. Estimated cost $1,500,000. Architect not selected.

Pa., Wilkes-Barre—The Central Poor Dist., G. K. Brown, Secy., 30 South Franklin St., will receive bids until Feb. 8, for mechanical refrigeration equipment.

Pa., Zelienople—The council, W. M. Seaton, Pres., will receive bids until February 6, for furnishing materials, labor and equipment and construction of a water filtration plant, including two 300,000 gal. per day mechanical filter units, with accompanying auxiliary works, one 350 gal. per min. motor driven centrifugal low-lift pump and other equipment as per plans and specifications. Hudson & Myron, 808 Wabash Bldg., Pittsburgh, Engr.

Tex., Beaumont—The City Comn., G. J. Roark, Mgr., will soon receive bids for the construction of 2 pumping stations in South Park and French Places. Estimated cost $30,000. W. L. Fulwiller, City Engr.

Tex., Breckenridge—The Great Texas Oil & Refinery Co. is receiving bids for the construction of a 2 story oil refinery, 5,000 bbls. daily capacity; storage capacity 200,000 bbls. Estimated cost $1,200,000.

Tex., Galveston — The Texas Bank & Trust Co., I. H. Kempner, Pres., is having plans prepared for the construction of an 11 story, 85 x 120 ft. bank and office building, including heating, ventilating and refrigerating systems. Estimated cost $800,000. A. C. Blossom, 680 5th Ave., New York, Archt. Sanquinet, Staats & Hedrick, Ft. Worth, Assoc. Archts. Noted Jan. 23.

Tex., Highland Park (Highland P. O.)—The city commission voted $125,000 bonds and will soon receive bids for the construction of well and main extension, also installation of pumping equipment, etc. Meyers & Noyes, Dallas County State Bank, Dallas, Engrs.

Tex., Houston — D. D. Pittman, Archt., Prince Theatre Bldg., will receive bids in April for the construction of an 8 story ice plant and warehouse for South Texas Cold Storage & Warehouse Co. Estimated cost $1,080,000. Equipment detail not reported.

Tex., Shamrock — C. L. Jones is in the market for an ice plant with oil pulling engine, pulleys, hangers, bearings, shafting and belting.

Va., City Point—The Wilson-Hock Co., N. Wilson, Mgr., is in the market for 50 to 100 hp. 3 phase, 60 cycle, 220, 440 or 2400 volt motors complete with starting equipment; steam double cylinder mine hoist, reversible double friction drum (geared type preferred) about 30 hp. complete with boiler, either vertical or locomotive type; two 13 ft. high cypress or yellow pine tanks, 13 ft. 6 in. in diam., etc.

Va., Prince George—J. E. Cousins, Jr., is in the market for deep well pumps and machinery.

Va., Richmond—L. F. Powell, Forest Hill, is in the market for 250 hp. steam engine and 150 hp. return tubular boiler.

Wash., Riverside—The Riverside Irrigation Dist voted $450,000 bonds for the irrigation of 4,000 acres, by constructing 2,800 to 3,000 hp. hydro electric power development on the Okanogan River at McLaughlin Canyon. Lift of pumps 30 to 100 ft., average 50 ft. N. Hall, Engr. Noted Jan. 23.

W. Va., Morgantown—The Morgantown Hotel Co. is having plans prepared for the construction of a 7 story, 55 x 175 ft. hotel. Estimated cost $400,000. S. F. Heckert, 620 Bessemer Bldg., Pittsburgh, Pa., Archt. Equipment detail not reported. Noted Dec. 19, 1922.

Wis., Brokaw—The Wausau Paper Mills Co. is having plans prepared for the construction of a 500 ft dam, 16 ft. head, including 11 tainter gates, gate hoist and earth fill. Estimated cost $25,000. L. A. De Guere, Wisconsin Rapids, Engr.

Wis., Dousman—Mead & Seastone, Engrs., State St., Madison, are preparing plans for the construction of a reservoir 30 ft. in diam, 10 ft. deep, and elevated steel tank 20,000 gal. capacity. A. D. Koch, Archt., will prepare plans for pump house and receive all bids in about 30 days. Above improvements to provide water supply for new Wisconsin Masonic Home, here. Estimated cost $20,000.

Wis., Fond du Lac—The Water Dept., J. J. Breister, Supt., will receive bids until February 15, for furnishing and installing a 5,000,000 to 10,000,000 gal. per day pump, steam or motor driven. Private plans. Noted Jan. 23.

Wis., Fort Atkinson—The Fort Atkinson Canning Co. will soon award the contract for the construction of a canning plant, including 3 story, 50 x 135 ft. main building, 42 x 150 ft. warehouse, 50 x 50 ft. cooking room, 30 x 40 ft. power house and 54 x 84 ft. vinery, all 1 story. Estimated cost $150,000. McMeans & Tripp, Majestic Bldg., Indianapolis, Ind., Engrs.

Wis., Milwaukee — The Central Bd. of Purchases will soon award the contract for three 42 in. diameter venturi tube meters, complete with 3 suitable register-indicating recording devices, also six 42 in. hydraulically operated gate valves for the Riverside Pumping Station.

Wis., Madison—The city, H. C. Buser, Clk., is receiving bids for air lift equipment and pump, complete with Booster tank, for city water supply. E. E. Parker, City Hall, Engr.

Wis., Oshkosh — The Wisconsin Dairymen's Storage Co., H. Krunery, Pres., Plymouth, plans the construction of a 2 story, 50 x 95 ft. cold storage warehouse. Estimated cost $50,000. Architect not selected. Owner is in the market for refrigerating machinery.

Wis., Port Edwards—The Nekoosa-Edwards Paper Co. is receiving bids for the construction of a 2 story, 158 x 188 ft. addition to paper mill. Estimated cost $150,000. E. P. Gleason, c/o owners, Engr. Contracts for 2 surface condensers and two 1500 kw. turbines, to Westinghouse Elec. & Mfg. Co., 425 East Water St., Milwaukee; 1200 hp. hydro electric unit to Allis-Chalmers Mfg. Co., West Allis. Estimated total cost of equipment $300,000.

Wis., Verona—Dane County, c/o M. Sommers, 512 West Wilson St., Madison, will receive bids until February 10 for piping, fittings, valves, belting, etc., for county power house here; also is having plans prepared for a 4 story, 100 x 140 ft. asylum building and cold storage building, estimated cost $150,000. A. D. Conover, Tenny Bldg., Madison, Archt.

Wis., Wausau—A. Kickbush Grocery Co., 126 West Washington Ave., is in the market for refrigerating machinery for proposed cold storage warehouse. Oppenhamer & Obel, Archts., will purchase.

Wis., Wauwatosa—The Forsyth Leather Co., State St., is having plans prepared for the construction of 40 x 50 ft. boiler house. Cahill & Douglas, Engrs., 217 West Water St., Milwaukee, are receiving bids on 3 horizontal boilers of 150 hp. each. Balance of equipment not decided upon.

Ont., Bridgeburg—The council, A. Williams, Mayor, plans the construction of a hydro electric lighting and power system, including a line from here to Stevensville, a distance of 8 mi. Estimated cost $50,000. Engineer not selected.

Ont., Monkton—The council, W. Scott, Reeve, plans the construction of a hydro electric lighting and power system. Estimated cost $30,000. Engineer not selected.

Ont., Sarnia—The Utilities Board, Mayor Cook, Chn., plans the installation of equipment to increase electric plant, 30,000 hp. Prices wanted on equipment.

Ont., Toronto—T. Eaton Co., Ltd., Yonge and Queen Sts., plans the construction of an 8 story, 120 x 200 ft. department store addition, including steam heating system. Estimated cost $500,000. Sproatt & Rolph, 36 North St., Archts.

Que., Carillon—The Quebec-New England Hydro Electric Corp., 263 St. James St., Montreal, A. E. Roberts, Pres., is in the market for machinery and equipment for power development, here.

Que., Shawenegan Falls—The St. Maurice Power Co., Ltd., J. C. Smith, Pres., is in the market for 4 vertical type turbines and generators each having capacity of 30,000 hp.

CONTRACTS AWARDED

Calif., Petaluma—The Petaluma Ice & Cold Storage Co., Postal Telegraph Bldg., San Francisco, awarded the contract for additions and alterations to cold storage plant, here, to the H. P. Vogensen Constr. Co., 600 5th St., Petaluma, about $20,000. Equipment detail not available. Noted Jan. 2.

Calif., Sacramento — L. Glide, c/o J. Morgan, Archt., Merchants Exchange Bldg., San Francisco, awarded the contract for a 2 story, 160 x 170 ft. market building on 13th and J Sts., here, to K. E. Parker, Clunie Bldg., San Francisco, $97,600. Equipment detail not reported. Noted Dec. 26, 1922.

Ind., Indianapolis—E. G. Spink Co., Hume-Mansur Bldg., will build a 9 story, 67 x 130 ft. physicians' building on North Pennsylvania St. Estimated cost $875,000. Equipment detail not reported. Noted Jan. 16.

Ind., Sullivan — The Vigo Mining Co., Rose Dispensary Bldg., Terra Haute, will build by day labor a 50 x 80 ft. power plant, near here. Estimated cost $75,000. Noted under Terra Haute Oct. 24, 1922.

La., Baton Rouge—The Bldg. Com. of the Louisiana State University awarded the contract for a 2 story engineering building, including heating and piping tunnels, also cottage for the professor of the Agricultural College, to Caldwell Bros., 859 Carondelet St., $167,432. Noted Jan. 9.

Md., Baltimore—The American Ice Co., Calvert Bldg., awarded the contract for the construction of a 2 story, 80 x 142 ft. ice plant on Eden St., to the North-Eastern Constr. Co., Lexington Bldg., $60,000. Ice-making machinery will be installed. Noted Jan. 23.

Md., Baltimore — The Mayor and city council awarded the contract for the construction of a 3 story Forest Park Senior-Junior High School, on Hawthorne Rd. and Clarendon Ave., to J. Henry Miller, Inc., Eutaw and Franklin Sts., $1,124,420. Steam heating ventilating and electrical equipment will be installed.

Mich., Detroit—The Development Corp., J. B. Book, Jr., Pres., Book Bldg., awarded the contract for the construction of a 25 story, 100 x 150 ft. hotel on Michigan Ave. and Washington Blvd., to the Lynch Constr. Co., 52 Vanderbilt Ave., New York. Estimated cost $5,000,000. Steam heating ventilating and electrical equipment will be installed.

Mont., Butte—The New Finlen Hotel Co., c/o J. Finlen, Finlen Hotel, awarded the general contract for the construction of a 9 story hotel to A. Broadland, Missoula, $265,378. Steam heating system will be installed. Noted Dec. 26, 1922.

N. Y., Brooklyn—V. Steinfold, c/o Slee & Bryson, Archts., 154 Montague St., will build by separate contracts two 6 story, 85 x 100 ft. apartment buildings, including steam heating system, on St. Johns Pl. Estimated cost $250,000 each.

N. Y., New York—The Joint Ownership Constr. Co., F. Culver, Pres., c/o Rouse & Goldstone, Archts., 512 5th Ave., will build by day labor, a 14 story apartment building on Lexington Ave. Estimated cost $500,000. Equipment detail not reported. Noted Apr. 19, 1921.

N. Y., Tupper Lake — The Bureau of Yards & Docks, Navy Dept., Wash., D. C., awarded the contract for lighting and electrical distribution for the U. S. Veterans' Hospital here, to the Strang Electric Co., 214 South 7th St., Phila., Pa., $48,662; heating, steam distributing system and boiler house equipment to The Shevlin Engr. Co., 259 West 34th St., New York, $171,868. Spec. 4718. Noted Nov. 28.

Pa., Butler—The Butler Memorial Hospital awarded the contract for the construction of a 3 story addition to hospital on Brady St., to W. M. Sutherland Building Const. Co., Commerce Bldg., Erie, Pa. Estimated cost $500,000. Equipment detail not reported. Noted Oct. 31, 1922.

Ont., Goderich—The Goderich Elevator & Transit Co., c/o J. A. Hunt, Horton St., London, awarded the contract for grain elevator, 1,000,000 bu. capacity, on the waterfront, here, to J. H. Tromanhauser, Confederation Life Bldg., Toronto, $250,000. Prices wanted on electrical grain handling equipment.